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Engineering Library

PUBLIC NOTICES

Applications are Invited for the POST of ENGINEER to Take Charge of Dmira at H.M.S. "Vernon," Portsmouth.

Salary £300, rising by annual increments of £15 to £400 and full Civil Service bonus, which at present increases £300 to £432.

The bonus corresponds to a cost of living index figure of 75 per cent., and is subject to increase or decrease by 1/25th for every five points rise or fall in the index figure.

Applicants should have a sound knowledge of Electro-technics and Physics; a sound knowledge and experience in the Design and Use of Electrical Apparatus as applied to Modern Acoustics; and should be capable of Supervising Initial Manufacture and Testing of Designs.

Experience in Research or Experimental Work will be taken into consideration.

Applications should be forwarded to the SECRETARY OF THE ADMIRALTY (C.E. Branch), not later than March 1st. 4924

Assistants (Three) Required by the GOVERNMENT of HONG KONG for service in the PUBLIC WORKS DEPARTMENT, for a period of three years, with possible permanency. Salary £460 per annum, rising by annual increments of £20 to £480 per annum; and thence (if appointment is made permanent) to £640 a year, plus a strictly temporary exchange allowance of 20 per cent. The salary is converted into dollars at the Government rate of exchange, at present fixed at 2s. to the dollar. This rate is open to revision. Conveyance allowance of 240 dollars per annum is paid. Free passages provided.

Candidates, unmarried, 24 to 30 years of age, must be fully qualified Architects' Assistants, well up in Building Construction and Drainage Work, able to Make Surveys and to Take Levels. Those possessing a knowledge of the law relating to Buildings, Public Health and Easements and who have had experience in the administration of Building and Public Health By-laws preferred.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting at head of application the reference number M/12,221. 4921

Civil Engineer to Supervise the Construction of Waterworks REQUIRED by the GOVERNMENT of TRINIDAD for two years' service. Salary, £800 per annum. Free first-class passages out and home and, if married, for wife and children also, not exceeding four persons. Two months' leave on full pay on satisfactory termination of agreement. Candidates, age 25 to 35 (preferably A.M.I.C.E.), must have had wide experience as a Contractor's Agents or Engineer in charge of the construction of Waterworks, comprising concrete dam, filter beds, service reservoirs, cast iron and steel mains with service connections, &c.—Apply at once by letter to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, stating age, qualifications, and experience, and quoting at top of application M/12,601. 4938

PATENTS AND DESIGNS ACTS, 1907 AND 1919.

Notice is Hereby Given that BRITISH ABCA REGULATORS, Limited, a British company, of 9, Bennetts-hill, Birmingham, SEEKS LEAVE to AMEND the SPECIFICATION (including the Drawings) of LETTERS PATENT No. 116,074, granted to Ragnar Carlstedt, for "Method of and Apparatus for Automatic Control."

Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), issued on the 6th February, 1924.

Any person, or persons, may give notice of opposition to the amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.

W. TEMPLE FRANKS, Comptroller-General. 4902

University of London.

A COURSE of SIX LECTURES on "PRACTICAL HYDRAULIC ENGINEERING PROBLEMS IN CONNECTION WITH NAVIGATION," will be given by Mr. O. C. A. VAN LIDTH DE JEUDE, C.E. (formerly Civil Engineer to the Netherlands Government Public Works Department, and now Technical Managing Director, Netherlands Harbour Works Co.), at the INSTITUTION OF CIVIL ENGINEERS (Great George-street, Westminster, S.W. 1) on MONDAYS, WEDNESDAYS and FRIDAYS, FEBRUARY 25th, 27th and 29th, and MARCH 17th, 19th and 21st, at 5 p.m. SYLLABUS: Dredging and Dredging Plant; Brushwood Constructions; River Improvements in the Netherlands; Harbour Engineering Abroad; Shipping Conditions in Port; the Zuider Zee Scheme. The lectures will be delivered in English and illustrated with lantern slides. ADMISSION FREE, WITHOUT TICKET.

EDWIN DELLER, Academic Registrar. 4960

Hull Municipal Technical College.

Principal: T. LUXTON, B.A., B.Sc.(Lond.)

MARINE ENGINEERING SCHOOL FOR ADULTS. To be opened on April 1st, 1924.

WANTED IMMEDIATELY, an INSTRUCTOR to act under the Head of the Engineering Department of the College and to devote himself mainly to the Instruction of Sea-going Engineers preparing for the Board of Trade Certificates.

Salary, £300 by £12 10s. annually to £350.

Applications, giving age, engineering training and sea-going experience, with Board of Trade qualifications and recent testimonials, should be forwarded to the undersigned immediately. A sheet of further particulars can be obtained on application.

J. T. RILEY, D.Sc. (London), Director of Education.

Education Offices, Albion-street, Hull. 4913

The University of Oxford will shortly proceed to APPOINT a DIRECTOR of the INSTITUTE for RESEARCH in AGRICULTURAL ENGINEERING at a salary of £800. Forms of application may be obtained from the SECRETARY to the Committee for Rural Economy, by whom applications will be received till March 15th. 4923

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Repair Works for the Underground Railways.

The Training of Aircraft Apprentices—No. III. (With a Two-Page Supplement).

Boiler Efficiency.

Super-Accuracy in Gear Ratios.

The Upkeep and Repair of Pneumatic Tools.

Pulverised Coal and its Preparation.

Goods Engine for India.

A Cold-Starting Oil Engine.

PUBLIC NOTICES

City of Birmingham Water Department.

The Water Committee of the Corporation of the City of Birmingham are prepared to receive TENDERS from competent firms for the MANUFACTURE and SUPPLY of about 1520 Lineal Yards of SOCKET and SPIGOT STRAIGHT PIPES, with a finished internal diameter of 23in. The pipes are to be of steel, and are to be lined by centrifugal method internally and covered externally with concrete or other approved material.

There will be, in addition, a number of Special Pipes.

Specifications and forms of Tender may be obtained from the Secretary of the Water Department, Council House, Birmingham, on payment of a sum of £1 1s., which amount will be refunded on receipt of a bona fide Tender.

Sealed Tenders, on the form provided for the purpose, addressed to "The Secretary, Water Department, Council House, Birmingham," and endorsed "Frankley New Reservoir, Contract No. 9," should be delivered at the Secretary's Office on or before Noon on Thursday, February 28th, 1924.

The Water Committee does not bind itself to accept the lowest or any Tender.

F. W. MACAULAY, M.Inst.C.E., Chief Engineer.
J. H. BROADLEY, Secretary.

Water Department, Council House, Birmingham, 18th February, 1924. 4931

City of Carlisle.

TO ENGINEERING CONTRACTORS.

PROPOSED IMPROVEMENT OF CALDEW BRIDGES.

The Corporation invite TENDERS from experienced contractors for the CONSTRUCTION of NEW CONCRETE ARCHED BRIDGES over the River Caldew and the Little Caldew, also Retaining Walls, Filling and Masonry Work in connection with the proposed improvement.

Firms desiring to tender should make immediate application, accompanied by a deposit of Two Guineas, to the undersigned. The deposit will be returned in full upon receipt of a bona fide Tender and the return of all documents.

Copies of the specification and quantities and schedule will be posted on Friday, 7th March, to contractors whose applications have been received, and the drawings will be open for inspection after that date.

Tenders, endorsed "Caldew Bridges, Contract No. 1," must reach the undersigned not later than 10 a.m. on Thursday, 20th March.

The successful contractor will be notified as soon as possible, and must arrange to actively commence the work on or before Monday, 31st March next, as this is a condition laid down by the Government, who are making a grant towards the carrying out of the work.

The lowest or any Tender will not necessarily be accepted, and parties tendering must do so at their own cost.

HENRY C. MARKS, M. Inst. C.E., City Engineer and Surveyor.

18, Fisher-street, Carlisle, 13th February, 1924. 4930

Dredger for Sale.

The Self-propelling LADDER BUCKET DREDGER "GLADSTONE," of Wick, belonging to the Wick Harbour Trustees, and now lying in Wick Harbour, is FOR SALE by PRIVATE TREATY. Full particulars may be obtained on application to Mr. W. E. Wookey, Harbour Engineer, or from the subscriber.

D. W. GEORGESON, Secretary.

Wick, 5th February, 1924. 4896

PUBLIC NOTICES

County Borough of Grimsby.

ELECTRICITY DEPARTMENT.

The Corporation are prepared to receive TENDERS for—

SPECIFICATION No. 180: STEAM and OTHER PIPEWORK.

The specification comprises H.P. Steam, Feed Water, Drain and Circulating Water Pipes for connecting up a 3000 K.W. Turbine, Two Boilers, &c., and alterations to existing pipework in connection with the extensions now being carried out.

One specification and drawing may be obtained gratis from the undersigned, and extra copies of same on payment of 7s. 6d. each.

Tenders are to be despatched so as to arrive not later than Monday, March 3rd.

W. A. VIGNOLES, Corporation Electricity Works, Grimsby. February, 1924. 4887

Manchester Corporation Waterworks.

The Waterworks Committee invite TENDERS for the CONSTRUCTION of CONCRETE STRAINING CHAMBERS and Supplementary Works at Lostock, near Bolton.

Specifications and forms of Tender, &c., may be obtained on application to the Secretary, Waterworks Offices, Town Hall, Manchester, on payment of Two Guineas, which sum will be returned only on receipt of a bona fide Tender.

All other inquiries respecting the work should be addressed to the Waterworks Engineer, at whose offices plans may also be inspected or lent on payment of One Guinea per set.

Sealed Tenders, endorsed as directed, must be delivered not later than the 25th instant.

By Order, P. M. HEATH, Town Clerk.

Town Hall, Manchester, 8th February, 1924. 4910

The Great Indian Peninsula Railway Company, 48, Copthall-avenue, London, E.C. 2, invite TENDERS for—

1.	BELLS, BIB COCKS, &c.	Fee 10s.
2.	LAMPS and FITTINGS	,, 2s.
3.	LEATHER BELTING, &c.	,, 5s.
4.	FERRO-PRUSSIATE PAPER	,, 2s. 6d.
5.	SPRING STEEL	,, 10s.
6.	SIEVES, &c.	,, 2s. 6d.
7.	GALVANISED WROUGHT IRON WATER TUBES, &c.	,, 10s.
8.	BRASS and IRON or STEEL SCREWS, &c.	,, 10s.
9.	PLATELAYERS' TOOLS	,, 5s.
10.	HELICAL SPRINGS	,, 10s.

Tenders are due by 11 a.m. on 26th February, 1924. Tender forms obtainable at above address. Fees not returnable. 4923

County Borough of Barnsley.

WATERWORKS DEPARTMENT.

APPLICATIONS are INVITED for the APPOINTMENT of WORKS MANAGER to Carry Out the Construction of a Storage Reservoir by Administration. Applicants, who must have had previous experience in similar work, may obtain all particulars of the duties, salary offered, &c., from the Waterworks Engineer, Doncaster-road, Barnsley. Engineering, in addition to management qualifications, will be an advantage. Applications, with copies of testimonials, must be sent to the Waterworks Engineer not later than midday, March 1st.

A. D. MASON, Town Clerk.

Barnsley. February 11th, 1924. 4890

PUBLIC NOTICES

The Announcement of the RESIGNATION of Mr. HAROLD LIVSEY, M.I. Mech. E., of the position of General Manager of Messrs. John Fowler and Company (Leeds), Limited, has been received with considerable interest in British and Continental Engineering Circles, in which Mr. Livsey was so widely known.

He has been associated with Messrs. Fowlers' business in various capacities for 26 years, and on his resignation the Directors have expressed to him their cordial good wishes for his success in any new sphere of operations which he may undertake. 4920

Port of London Authority.

APPLICATIONS are INVITED for the POSITION of CHIEF DRAUGHTSMAN.

Candidates must not exceed 45 years of age and must be capable of Organising and Controlling the Staff of a large Drawing-office. They must have had thorough experience in the Design of Bridges, Caissons, Gates and Dock Entrances, and General Dock and Railway Construction and Equipment Work, and also experience in the Preparation of Charts, Reductions and Enlargements.

Applications, giving particulars of experience qualifications, &c., and stating salary required, must be on the prescribed form obtainable from the Staff Manager, Port of London Authority, E.C. 3, and be delivered not later than the 31st March, 1924.

Any canvassing of members of the Authority by or on behalf of an applicant will entail the application being ignored.

F. AYLIFFE, Secretary. 4919

Port of London Authority.

APPLICATIONS are INVITED for the POSITION of MECHANICAL ENGINEER.

Candidates must not exceed 45 years of age, and must be fully qualified Members of the Institution of Mechanical Engineers, with wide experience in the Design, Construction, Maintenance and Running of the Mechanical Equipment of Docks and Harbours, including Electrical and Hydraulic Installations, Pumping, Refrigerating and Grain-discharging Machinery, Cranes, Conveyors, Locomotives, Lock-gate Machinery and Bridges, &c.

Applications, giving particulars of experience, qualifications, &c., and stating salary required, must be on the prescribed form, obtainable from the Staff Manager, Port of London Authority, E.C. 3, and be delivered not later than the 31st March, 1924.

Any canvassing of Members of the Authority by or on behalf of an applicant will entail the application being ignored.

F. AYLIFFE, Secretary. 4920

SITUATIONS OPEN

WANTED, ENGINEER as ASSISTANT WORKS SUPERINTENDENT; must have good experience in running H.P. Air Compressors; slight Chemical Knowledge and Managerial Experience an advantage.—Address, giving age, experience and salary required, 4882, The Engineer Office. 4882 A

WANTED, in Large Structural Works, South Wales, ASSISTANT to WORKS MANAGER; young, energetic, with experience of work in Constructional shops, and suitable technical knowledge.—Address, stating age, experience, qualifications, whether married or single, &c., 4754, The Engineer Office. 4754 A

WANTED, TWO First-class MEN for ESTIMATING and RATE-FIXING; used to Instrument Work and Tool Making. Only those with a thorough practical experience and accustomed to Laying Out Sequence of Operations and Speeds and Feeds need apply. State age, experience, and salary required.—Address, 4801, The Engineer Office. 4801 A

WANTED, YOUNG ENGINEER. Unmarried, resident in London, preferably with some knowledge of Chemical Engineering, to Push Sale of Speciality among consulting engineers and large works.—Write, stating age and qualifications, to Box S. 155, Willing's, 119, Moorgate, E.C. 2. 4909 A

ARTESIAN WELL ENGINEERS REQUIRE at once practical experienced OUTSIDE MAN, to Supervise Well Sinking, Reading and Boring Jobs.—State age and full details of experience to LE GRAND, SUTCLIFF, Southall, London. 4876 A

ASSISTANT CIVIL ENGINEER, Tropical Railway, Spanish-speaking, unmarried, experience abroad.—Address, full record, to "A. K.," c.o. J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 4918 A

ASSISTANT WORKS MANAGER.—ADVERTISERS (Box 4632) ACKNOWLEDGE with thanks the numerous REPLIES to their recent advertisement. Interview appointments will be made with suitable candidates. 4915 A

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SITUATIONS OPEN (continued)

ENGINEER WANTED as STAND ATTENDANT at Empire Exhibition. Must have good general knowledge of Power Requirements. State age, experience and salary required.—Address, 4928 The Engineer Office. 4928 A

ELECTRIC WELDING.—REQUIRED, EXPERT to Sell and Demonstrate Electric Seam, Spot and Butt Welding Machines; connection amongst users essential. Give full particulars of experience, and state salary required.—Address, P8670, The Engineer Office. P8670 A

ELECTRICAL ENGINEER. Thoroughly Capable, with sound technical and practical experience, REQUIRED as Assistant to Chief Mechanical Engineer. Experience in Modern Colliery Practice an advantage. State full experience, age and salary required.—Address, P8686, The Engineer Office. P8686 A

ENGINEER REQUIRED to TAKE CHARGE of the Maintenance and Economical Running of Machine Tools in an Electrical Manufacturing Works, S.W. district. Good Fitting and Turning experience necessary. Only applicants with drawing-office experience considered.—Address, giving full experience, age and wages required, 4937, The Engineer Office. 4937 A

ENGINEER-SALESMAN. Age About 30, REQUIRED for London Office of Constructional Engineers. A trained engineer with selling experience preferred. Applications should state qualifications and salary required.—Address, 4903, The Engineer Office. 4903 A

IMPORTANT ENGINEERING FIRM, London district, REQUIRE the SERVICES of a PRODUCTION ENGINEER; Scotsman preferred; investment £1500. Applicant must possess exceptional controlling ability, and have good experience in Shop Work, and be able to act in capacity of Works Manager if necessary.—Address, P8678, The Engineer Office. P8678 A

LONDON MERCHANT FIRM REQUIRE the SERVICES of an ENGINEER, with thorough knowledge of Machinery for Export abroad. Age not more than 35. Sal. £500-£750 p.a., according to qualifications.—Apply, LAURIE and CO., Employment Specialists, 28, Basinghall-st., E.C. 2. No preliminary fee. 4934 A

POWER ENGINEER.—REQUIRED for Works in Midlands, ENGINEER, competent to Take Charge of Power-house, including complete electrical installation, heating, lighting, electrical pumps and synchronous set, also steam-driven pumps, hydraulic accumulators and boiler plant.—Address, giving full particulars as to training, qualifications, age, experience and salary required, 4904, The Engineer Office. 4904 A

REPRESENTATIVE REQUIRED for London and South of England, with knowledge of Steam and Gas-cooking Apparatus, able to draw up plans and specifications for large installations.—Apply by letter, stating age, experience and salary required, to McDOWALL STEVEN and CO., Ltd., 2, Upper Thames-street, E.C. 4. P8673 A

SALES ENGINEER REQUIRED, London District, with knowledge of Power Plant Instruments, for calling on power stations, consulting engineers, &c. State full particulars, salary, connection, experience.—Address, 4912, The Engineer Office. 4912 A

WORKS MANAGER REQUIRED, Capable of Organising Production Methods and Output, Machining, Furnace Work, Screwing and Order Progress. Experienced man required; permanent position. State age, qualifications and references.—Address, 4932, The Engineer Office. 4932 A

WANTED AT ONCE, DRAUGHTSMAN, Experienced in Design of High-pressure Turbo-compressors.—Apply, stating age, practical and theoretical training, salary required, and when free, to REAVELL and CO., Ltd., Ranelagh Works, Ipswich. 4914 A

WANTED, by a Firm of Constructional Engineers in London, a competent DRAUGHTSMAN. State age, experience and salary required.—Address, P8681, The Engineer Office. P8681 A

WANTED, First-class DRAUGHTSMAN for Structural and Mechanical Work on Coal and Coke-handling Machinery. Good structural experience essential.—Reply, giving full particulars, including age and salary required, to STRACHAN and HENSHAW, Limited, Engineers, Bristol. 4839 A

WANTED, FIRST-CLASS DRAUGHTSMAN, with thorough knowledge of Hydraulic Machinery and Shipyard Tools; good salary and permanent position for suitable man. Only fully qualified and experienced men need apply, stating age, salary required, experience, &c.—Address, 4917, The Engineer Office. 4917 A

A LARGE ENGINEERING FIRM in the Manchester District REQUIRES the SERVICES of an efficient and capable DRAUGHTSMAN on Steam Turbines, preferably having had experience on Land Machines.—Applications are invited from first-class men, who should write with full particulars as to age, experience, and salary required, to 4884, The Engineer Office. 4884 A

CHIEF DRAUGHTSMAN REQUIRED for Washary Department. Applications are invited from men who have had first-class experience in the Preparation and Checking of Drawings for economical works production. A knowledge of Baum System Washery Plants is desirable, but not essential.

Apply, in strict confidence, to the GOVERNING DIRECTOR, Sortons (Tividale), Ltd., Heck Works, Tividale, Tipton, stating fully previous experience, positions held, age and salary required. 4907 A

DRAUGHTSMAN, Experience Sheet Metal Work, Light Steel Work, Nest Tracing and print essential, REQUIRED IMMEDIATELY London. Salary £4 to £4 10s.—Address, full particulars, age, experience, 4936, The Engineer Office. 4936 A

DRAUGHTSMAN REQUIRED by Engineering Works in Midlands, having first-class experience in Designing Small Direct-current Dynamos and Motors of high efficiency and low cost. Only those who have been in charge of similar work will be considered. Good pay and prospects.—Address, with full statement of experience and salary required, 4886, The Engineer Office. 4886 A

DRAUGHTSMEN REQUIRED by METROPOLITAN-VICKERS ELECTRICAL CO., Ltd., Trafford Park, Manchester. Applicants must be capable and efficient, and should preferably have had a good experience on Transformer Work.—Apply in first instance by letter to EMPLOYMENT DEPARTMENT, stating age, training and salary required. 4889 A

DRAUGHTSMAN REQUIRED. Only Those who are accustomed to Designing Electrical Installation for Factories need apply. State details of experience, age and salary required.—Address, 4905, The Engineer Office. 4905 A

DRAUGHTSMAN REQUIRED TEMPORARILY in London, to prepare Drawings for large Railway Sheds and General Constructional Work.—Address, 4883, The Engineer Office. 4883 A

DRAUGHTSMAN WANTED by Firm in the Midlands manufacturing Municipal Vehicles. Applicants should state age, experience and salary required, and enclose copies of references.—Address, P8676, The Engineer Office. P8676 A

FIRST-CLASS DRAUGHTSMAN FOR THE NORTH OF ENGLAND.—WANTED, a MAN with sound experience of Cement and Crushing Plants, who is capable of undertaking the Design of the Machinery and General Lay-out of such Plants.—Address, giving details of experience, age and salary required, 4892, The Engineer Office. 4892 A

Edward Arnold & Co.'s Book List.

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W. E. DALBY, F.R.S.

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London: EDWARD ARNOLD & CO., 41 and 43, Maddox Street, W. 1.

SITUATIONS OPEN (continued)

FIRST-CLASS DRAUGHTSMAN WANTED for North of England, with experience in the Design and Construction of Large Winding and Hauling Engines, steam and electrically driven.—Address, giving particulars, age and salary required, 4891, The Engineer Office. 4891 A

JUNIOR DRAUGHTSMAN WANTED Temporarily for London; accustomed to Small Machine Lay-outs, Shafting, &c. State age, experience and salary required.—Address, P8691, The Engineer Office. P8691 A

FOREMAN MILLWRIGHT REQUIRED for Steel Works, comprising melting shop, plate mills and sectional mills. Applicants must be trained engineers, having had a wide experience in up-to-date steel works, both in the maintenance and the erection of plant, and only applicants who have had such experience and held position of responsibility will be considered.—Full particulars of experience and positions held, together with copies of testimonials, also salary required, to be sent to the SECRETARY, Consett Iron Co., Ltd., Consett, Co. Durham. 4893 A

LOCOMOTIVE FITTER.—WANTED for Sugar estates, East Africa, good WORKING FITTER, accustomed to running repairs; 3 years' agreement.—Write, stating age, experience, wages, to Box K. T., c.o. Davies and Co., 95, Bishopsgate, E.C. 2. 4893 A

SITUATIONS WANTED

A.M.I. MECH. E., 35, DESIRES CHANGE; four years shops, five years railway work abroad; four years with B.E. workshops, France; 4½ years with large public company; thorough knowledge all classes of machinery and mechanical transport.—Address, P8654, The Engineer Office. P8654 B

A.M.I. MECH. E., age 33, Married, at Present Engaged, DESIRES POSITION, Australia; specialised lines, fuel economy, expert and chemical engineer, gas and coke oven bye-products plants, &c.; fully trained, both practical and commercial; complete control large staffs and labour, with knowledge and foresight to obtain best results; willing act as representative or in managerial capacity. Salary required.—Address, P8675, The Engineer Office. P8675 B

CHARTERED CIVIL ENGINEER (38), 12 years' administrative experience, design, manufacture and sales, OFFERS PERSONALITY and ABILITY as Manager, Departmental Chief or Representative, home or abroad.—Address, P8682, The Engineer Office. P8682 B

COST ACCOUNTANT (32), Desirned, Organised and Controlled costing systems of three engineering firms; also three years' office manager; expert on accountancy, costing and stores administration. AVAILABLE IMMEDIATELY through trade depression.—Address, P8672, The Engineer Office. P8672 B

ENGINEER (28) DESIRES POST at Wembley, or in London District as Representative or Demonstrator; machine tools, internal combustion engines, motors, or drop stampings. Fully experienced, excellent references.—Address, P8671, The Engineer Office. P8671 B

ENGINEER (43), B.Sc., A.M.I.E.E., Wide Electrical experience, 10 years charge electrical installation on large chemical works, used to lay out, operate and maintain A.C. and D.C. plant, some years commercial experience, DESIRES APPOINTMENT.—Address, P8601, The Engineer Office. P8601 B

ENGINEER (48), Experience, 15 Years Designing, testing, experimenting, works management, manufacturing road transport vehicles, 9 years own business, and on directorate road transport concern, POSITION WANTED.—Address, P8627, The Engineer Office. P8627 B

ENGINEER SEEKS RESPONSIBLE ADMINISTRATIVE POSITION with Contractor. Thoroughly experienced.
Address, P8669, The Engineer Office. P8669 B

EXPERIENCED LADY SHORTHAND-TYPIST REQUIRES POSITION with Engineers; reduced salary for 4 weeks to acquire tech. terms.—Address, P8692, The Engineer Office. P8692 B

SITUATIONS WANTED (continued)

MINING and METALLURGICAL ENGINEER, broad commercial and technical experience Russia, U.S., Asia, SEEKS CONNECTION British concern, Europe or Russia. Thirty-nine years of age, naturalised American; speaks Russian and French; present location Asia. List of references Engineer Office. Will report duty thirty days receipt firm offer.—Address, 4852, The Engineer Office. 4852 B

PRODUCTION SPECIALIST, Designer Jigs, Tools, practical toolmaker, long experience motors, air craft fittings, SEEKS APPOINTMENT in South or London.—Address, 4854, The Engineer Office. 4854 B

STEEL-SMELTING.—POSITION REQUIRED as PRACTICAL MANAGER of OPEN-HEARTH PLANT at home or abroad. First-hand or sample passer. Good and practical experience in English and foreign steel works; distance no object.—Box H., Kidd's Advertising Agency, Middlesbrough. 4884 B

AUTOMOBILE.—CHIEF DRAUGHTSMAN and DESIGNER in the employ of a prominent firm of motor car manufacturers DESIRES a CHANGE.—Address, P8688, The Engineer Office. P8688 B

DRAUGHTSMAN SEEKS OPENING as ESTIMATOR or TECHNICAL ASSISTANT.—Address, P8679, The Engineer Office. P8679 B

DRAUGHTSMAN (28), Used to Responsibility, DESIRES CHANGE; thorough knowledge design and lay-out of all types of modern rolling mills and hydraulic plants; home or abroad.—Address, P8690, The Engineer Office. P8690 B

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For continuation of Small Advertisements see page 3.

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New Metal Grinding Regulations.

THE regulations made by the Home Office in October, 1909, regarding the grinding of metals and the "racing" of grindstones, were limited, pending further inquiry, to the manufacture of cutlery and edge tools. Since that date a comprehensive inquiry has been proceeding into all aspects of grinding, and in June last year the Home Office issued a report of the findings arrived at as a result of that inquiry. The Home Secretary is now circulating a draft of the regulations which he proposes to make to give effect to the findings. All concerned with the grinding and polishing of metals, as well as with the cleaning of castings by rumbling, sand-blasting, or other process, should examine the draft with great care, for a study of the regulations indicates that modifications of practice and customs will be imposed by them in several important respects. It is gathered that, following the remarks made in the report concerning the more or less innocuous nature of the dust generated during machine grinding with wet, manufactured wheels of the emery type, the engineer's grinding machine can be regarded as exempt from the regulations. It is the sandstone grinding wheel, whether used wet or dry, that the regulations—apart from the cleaning of castings—chiefly apply to. The report discountenanced the prevalent belief that the use of a wet grindstone largely, if not wholly, eliminates the risk attendant upon the presence of siliceous dust. In the proposed regulations, one of the clauses requires that the usual practice of running the stones in a bath of water shall be replaced by the employment of a constant stream of fresh water delivered on to the top of the stones and drained away from below. Anyone desiring to make objections in connection with the regulations has forty days from February 8th within which to lodge them with the Secretary of State.

Aerial Mail Services.

THE report of the Air Mails Committee, presided over by Lieut.-Colonel Moore-Brabazon, appeals to us as being a praiseworthy endeavour to face the truth in the matter of our aerial mail services. The amount of mail traffic on the cross-Channel routes, in spite of a high standard of efficiency, is still quite small, a fact which the Committee ascribes to the inherent nature of the system. The chief trouble is that the existing routes are too short. In competition with highly developed rail and steamer services, the loss of time in ground conveyance at each end is a very serious factor telling against aerial mail transport on a short route, such as between London and Paris. The absence of night flying is also a detrimental feature, although even an efficient night service on a short route would not save the situation. At present an air letter to be delivered in Paris before the close of business must be posted in London by 11 a.m. at the latest, an hour before which few business letters are written. To compete with the aeroplane for the first delivery the following morning, the rail and steamer services have thus the afternoon and the whole of the night-time in which to perform the transport. Even with a night aerial service the position would not be improved, for the letters conveyed by it would, while arriving earlier than by rail and steamer, have to await the opening of business before being delivered and attended to. The employment of aeroplanes for expediting the delivery of mails arriving in this country by the Atlantic liners is hampered by a similar consideration, for the success of the scheme is dependent very largely upon the liners arriving regularly and in the early hours of the morning. The ideal route on which aeroplanes might be employed for mail purposes is, in the Committee's opinion, one on which a whole day's flight would be preceded and followed by a whole night's rail or sea transit. As regards night flying, it is held that its development will be of advantage in the case of towns 800 miles or more apart.

The Liner Statendam.

FOLLOWING the departure of the Cunarder Olympic from Belfast last week after reconditioning at the yard of Harland and Wolff, Limited, it is announced that work will be resumed on the Holland-America liner Statendam. This 30,000-ton ship was ordered over two years ago, but after her keel was laid work on her was stopped owing to the increase in the costs of production. The Statendam is being built in the firm's new East Yard, and she bears the distinction of being the largest vessel under construction in the world at the present time. She is intended for the Rotterdam-New York passenger service and is to be fitted out with accommodation for about 3000 passengers. Some of the internal decorative work will be particularly fine, much of it being prepared from original designs by the well-known Dutch firm of ships' decorators, Mutters, of The Hague. Several of the designs were seen when these works were visited by the members of the Institution of Naval Architects in September last. We are informed that the decision to resume work on the ship is largely due to Lord Pirrie's desire to relieve, as far as possible, unemployment in Belfast and district. It is understood that the Government of Northern Ireland will give assistance under the provisions of the recently passed Trade Facilities Act.

The Scapa Salvage Contract.

IT is announced that a contract has been concluded between the Admiralty and Cox and Danks, Limited, Regent-street, London, for the raising of the majority of the German warships which were scuttled at Scapa Flow on June 21st, 1919. The salvage operations will be, we understand, on a scale quite unparalleled in the past history of salvage work, and entirely new plant, with special appliances and tackle will be used. As is well known, the firm of Cox and Danks own the engineering and shipbreaking yard at Queenborough, Kent, and the expedition is at present in course of being fitted out at that yard. All being well operations at Scapa are expected to be begun about the end of March. There was considerable interest displayed in the contract, and several salvage and shipbuilding companies competed for it, including, we understand, an American syndicate. In some cases considerable premiums were offered for the rights to raise and sell the sunken ships.

New Aircraft Carrier's Maiden Commission.

ON Tuesday next, the 19th inst., H.M.S. Hermes is to begin her maiden commission, with a Portsmouth crew, for service in the Atlantic Fleet. This vessel is the first of the type designed for the specific purpose of transporting aircraft, the plans having been drafted by the Admiralty constructors in the early part of 1917. She was laid down by Armstrong, Whitworth and Co. in January, 1918, and launched in September, 1919. Her trials began last August, but she was subsequently returned to Devonport Dockyard for certain minor alterations in her aircraft handling gear. Such details of this interesting ship as the Admiralty has permitted to be published have already appeared in our columns. It is understood that the aviation tests made last autumn showed the Hermes to be well adapted for service as a floating aerodrome, in spite of her comparatively moderate tonnage. Although of not more than 10,950 tons displacement, she has a flight deck with an overall length of 598ft. and a breadth of 90ft. She is propelled by Parsons geared turbines of 40,000 shaft horse-power, and a speed of 25 knots was easily attained on her steam trials. Twenty aeroplanes or seaplanes can be stowed in the hangars below deck, where there are well-equipped shops for the repair and adjustment of aircraft and their engines. Magazines are also provided for torpedoes and bombs. Six 6in. guns are mounted in sponsons along the broadside, and on the flight deck two 4in. anti-aircraft guns are placed before and two abaft the superstructure. With her full quota of Royal Navy and R.A.F. *personnel* on board, the Hermes has a complement of 664. She is under the command of Captain the Hon. A. Stopford, who was appointed to her early last year. On commissioning she will relieve the Argus, the "funnel-less" aircraft carrier, which has been attached to the Atlantic Fleet since 1919.

Tyne Bridge Project.

ANOTHER step towards the construction of an additional bridge across the Tyne was taken on Monday, when the Joint Committee set up by the Corporations of Newcastle and Gateshead confirmed the proposals, already put forward, for a bridge at St. Anthony's. It seems, however, that some further discussions will have to take place before the matter is finally settled. The railway company, for instance, is not promoting a Bill for the construction of a bridge at St. Anthony's this year, and any effort towards the building of a composite bridge to carry both trains and road traffic must thus meet with delay. On the other hand, there seems to be a considerable body of opinion in favour of the construction of a bridge for ordinary road traffic on one deck, with a way below for tram cars. The whole matter is complicated by the requirements of navigation on the river, which, the Tyne Improvement Commissioners suggest, necessitate a head-room of 110ft. The Commissioners, however, say that they are prepared to discuss this matter if the promoters of the bridge desire to do so.

Road Transport in Coal Mines.

IN a recent Journal note we made mention of the proposal for standardising colliery requisites. On Saturday last, when reading a paper on underground transport before the Mining Institute of Scotland, Mr. A. V. Reis contributed some interesting notes on the important subject of underground roads and their proper equipment. After visiting a large number of mines in England and also on the Continent, his impression, he said, was that the problem had largely been treated with indifference. There was urgent need for good roads, good tracks, with an ample supply of well-designed tubs and good systems of haulage. Haulage roads should be permanently built, with ample dimensions, and, if possible, they should be made of standard width. With the increased use of coal-cutting machines, there was a tendency to improve the transport from the face to shaft so that all coal cut in one shift could be dealt with. There was a remarkable difference in tub capacities. In Scotland "hutches" were made to carry 10 cwt., while in America tubs dealing with 16 cwt. to 20 cwt., and in South Wales from 25 cwt. to 40 cwt. were used. If good roads were maintained, 1-ton tubs would pass just as easily as tubs containing only half that amount.

Another Coal Field.

THERE is prospect, in news which comes from Lincolnshire, that the industrial section of the country may invade, even further, the land which is generally considered as essentially agricultural. Already arrangements have been made for boring for coal at Doddington, about midway between Retford and Lincoln, and now it is announced that a similar project is on foot in the Isle of Axholme. A syndicate, with headquarters at Doncaster, has secured an option on some land held by the Lincoln Corporation, and proposes to start boring very shortly. The new syndicate is said to have secured rights over an area of some 500 acres, while the Doddington enterprise covers nearly 5000 acres. Some preliminary borings have already been made, and it is anticipated that coal will be discovered at a depth of from 900 to 1000 yards. The new exploratory borings will probably take from a year to fifteen months to complete.

Liverpool as a Manufacturing Centre.

LISTENING to the speeches at the annual dinner of the Liverpool Engineering Society held last week, one could not help recalling the marked industrial changes that have taken place in Lancashire to Liverpool's disadvantage during the last twenty years or so. The construction of the Ship Canal, which made Manchester a seaport of prime importance, was the commencement of an epoch of far-reaching influence on the geography of the county. This canal has been the means of bringing into the South Lancashire area a large number of factories of all kinds—textile, chemical and engineering. Owing to the facilities which this waterway provides, important works have grown up on the canal banks which otherwise might not have found a home in the county at all, and Liverpool has failed to secure the share of industrial undertakings which it ought to have done. Geographically, Liverpool compares favourably with most of our large northern cities for manufacturing purposes. If asked, then, what the reason can be for this state of affairs, one can only suggest lack of enterprise on the part of the municipality. Yet this is not entirely true. It is rather that Liverpool's energies have been turned into other channels, the chief of which is transportation. The Mersey Dock and Harbour Board, with its magnificent system of docks and warehouses, has always been in the forefront for enterprise, and is ever extending and developing its facilities. The Liverpool Corporation, on the other hand, seems to have been content to watch shiploads of raw material passing its very doors up the Mersey to factories further inland and near the Ship Canal. Neither is Liverpool's great traffic problem across the Mersey any nearer settlement. This has been discussed from many points of view for many years, but the most practicable scheme—namely, that of a tunnel, which has been evolved by three eminent engineers—is still no further advanced than the talking stage.

The Object of Granting Patents.

IN an address entitled "Discovery," which he delivered on Monday last at the annual general meeting of the Institution of Heating and Ventilating Engineers, Sir George Croydon Marks referred to the misapprehension in the popular mind as to the reason for the grant of a patent by the State. What the State sought, he said, was the development of new industries, or the improvement of its industrial resources, based upon that which the inventor had originated or produced. In other words, it was something in the nature of a bargain, or contract, between the State and the individual by which the latter surrendered the prospective sole enjoyment of his invention for a State-protected limited period of monopoly. By that bargain the State secured for the nation the free use of the invention at the end of the protected period, and gave to the nation the benefit of the improvement, or the new industry, which, but for the inventor, would not have had existence. Sir Croydon also warned his audience against the proposal relating to inventions lately brought before the League of Nations, which suggested protection not only during the life of the discoverer, but for fifty years afterwards. If that suggestion were to be put into operation, it would, he said, have a disastrous effect on industries depending on the development of scientific knowledge.

Super-accuracy in Gear Ratios.

By T. M. LOWTHIAN and W. OWEN, M.I. Mech. E.

THE study of gear ratios and how to obtain them is a subject of interest to most engineers, and of absorbing interest to those connected with the production of gearing. This, of course, is the result, primarily, of the tremendous strides made during recent years in the production of gearing, accompanied necessarily with the demand for more and still more accuracy, or, should we say, less and still less inaccuracy? Most master dividing wheels, which a few years ago were considered to be almost the last word in accuracy, would to-day be scornfully rejected, and, particularly in turbine gearing, no trouble is too great and no expense too heavy to ensure that these wheels shall be as accurate as they can possibly be made. This struggle for practical accuracy has its counterpart in just as keen a struggle for theoretical accuracy, one of the results of which has been the development of the method of calculating gear ratios about to be described.

The outstanding object of this investigation has been to devise, if possible, a method which even the office boy could use, and it will be seen that, not only are the methods extremely simple—not even logarithms are used—but they have been presented in as simple a manner as possible. It must be pointed out that the object has not been to discover a quick method—there are two or three of these—but to get as near as possible to the desired ratio, and to illustrate this, instances are given in which ratios have been obtained correct to eight places of decimals. Further, in order to make the scheme as comprehensive as possible, it was decided to permit the use of change gears from 14 to 199T in single and double trains only, and the examples given herewith have been worked out upon that basis. A few instances of the scope of this method are here given, but it should be mentioned that in no case has the total number of ratios been exhausted.

All examples have been taken at random except No. 5 for π, and this is an old and well-known ratio which gives the nearest correct solution obtainable by double trains. Some ratios can be worked out correctly up to from eight to any number of places of decimals. Ratios of all numbers containing more than six places of decimals can be worked out up to six places of decimals, and in this class the ratios can advance by units in the sixth place—see example 30–42. The only exception to the last class is where the figure repeats itself—see example 7 to 13. Here it will be noticed that we get ratios from one to four places of decimals correctly, in the next one the figure is recurring. To get the same figure correct to five places of decimals—see example 15—we have to increase the ratio beyond that of the figure recurring.

Examples 1 to 42.

No.	Change wheels.	Ratio.	Feature.
1	$\frac{14 \times 14}{199 \times 199}$	.0049493699 +	Minimum ratio obtainable
2	$\frac{197 \times 199}{198 \times 198}$	.9999744923 +	Maximum ratio obtainable
3	$\frac{109 \times 178}{195 \times 199}$	.4999871150 +	Having given one ratio, shows how near another ratio can be got to it correct to eight places of decimals
4	$\frac{126 \times 154}{197 \times 197}$	.4999871163 +	
5	$\frac{71 \times 100}{20 \times 113}$	3.1415929203 +	π = 3.141592653589 +
6	$\frac{41 \times 51}{85 \times 185}$	.3937042925 +	10 mm. = 3937043196
7	$\frac{20 \times 15}{30 \times 100}$	.1	A figure repeating itself from one to four places of decimals. Similar ratios can be got for all figures from 1 to 9
8	$\frac{55 \times 15}{75 \times 100}$	.11	
9	$\frac{37 \times 15}{50 \times 100}$	.111	
10	$\frac{101 \times 22}{125 \times 160}$	.1111	
11	$\frac{21 \times 191}{190 \times 190}$	.1111080332 +	
12	$\frac{44 \times 98}{197 \times 197}$	.1111082480 +	
13	$\frac{40 \times 110}{199 \times 199}$	.1111083053 +	A figure repeating itself to four places of decimals. Similar ratios can be got for all figures from 1 to 7
14	$\frac{30 \times 20}{60 \times 90}$	.1	Figure recurring. Similar ratios can be got for all figures from 1 to 8
15	$\frac{44 \times 99}{197 \times 199}$	.1111139453 +	A figure repeating itself to five places of decimals, but the ratio has increased beyond the recurring figure ratio
16	$\frac{20 \times 15}{135 \times 180}$	.012345679	Single figures in order forward to eight places
17	$\frac{40 \times 100}{45 \times 90}$	.987654320	Single figures in order backward to eight places
18	$\frac{20 \times 109}{99 \times 198}$	.111213141516, &c., tried up to 33	Double figures in order forward
19	$\frac{46 \times 71}{99 \times 99}$	.333231302928, &c.,	Double figures in order backward
20	$\frac{20 \times 50}{99 \times 99}$	.102030405060, &c.	Figures increasing in 10's
21	$\frac{70 \times 113}{99 \times 99}$	.807060504030, &c.	Figures decreasing in 10's
22	$\frac{20 \times 55}{99 \times 99}$	.1122334455	Pairs in order forward
23	$\frac{20 \times 173}{55 \times 81}$	.7766554433	Pairs in order backward
24	$\frac{30 \times 20}{60 \times 137}$	.07299270	Four figures and same reversed
25	$\frac{47 \times 71}{165 \times 182}$	.1111222	A peculiar ratio
26	$\frac{14 \times 167}{143 \times 147}$	.111222	Triplicate figures in order forward
27	$\frac{23 \times 29}{33 \times 91}$	.222111	Triplicate figures in order backward
28	$\frac{35 \times 127}{73 \times 137}$	.44445555	Quadruplicate figures in order forward
29	$\frac{59 \times 113}{73 \times 137}$	.66663333	Quadruplicate figures in order backward
30	$\frac{187 \times 199}{191 \times 195}$	.9991408242 +	Sample ratio taken as base
31	$\frac{17 \times 137}{37 \times 63}$	.9991419991 +	Range of ratios advancing by units in the sixth place of decimals
32	$\frac{141 \times 157}{116 \times 191}$	.9991424444 +	
33	$\frac{35 \times 100}{31 \times 113}$	.9991435912 +	
34	$\frac{27 \times 173}{55 \times 85}$	.9991443850 +	
35	$\frac{35 \times 167}{50 \times 117}$	.9991452991 +	
36	$\frac{97 \times 181}{92 \times 191}$	.9991463692 +	
37	$\frac{33 \times 71}{35 \times 67}$	.9991471215 +	
38	$\frac{109 \times 183}{124 \times 161}$	.9991484672 +	
39	$\frac{25 \times 47}{28 \times 42}$	.9991496598 +	
40	$\frac{26 \times 181}{30 \times 157}$	.9991507430 +	
41	$\frac{22 \times 107}{31 \times 76}$	.9991511035 +	
42	$\frac{45 \times 131}{59 \times 100}$	.9991525423 +	

No ratio can have the same figure repeating itself more than five times except as a recurring decimal. Figures 1 and 2 are the only figures that can be repeated five times.

It frequently occurs that, being given a required ratio, the nearest ratio obtainable to it may not be correct to as many places of decimals as another ratio which is correct to one more place of decimals.

As an illustration of this take the example for 10 mm. = .3937043196 Now,

$$\frac{94}{107} \times \frac{128}{183} = .3937043944$$

This is correct to seven places, but the example given in the list No. 6, although only correct to six places, is nearer than that given above.

METHOD OF WORKING OUT.

To facilitate the calculations it is advisable, though not absolutely necessary, to have a ratio table for all numbers from 1 to 199. This has been worked out, but as it would be too voluminous to print complete, the change wheels can be obtained from the ratio in the usual way.

RECURRING DECIMALS.

It may appear odd to do so, but it is proposed to commence with repeating decimals, as these generally have, in this connection, been sadly neglected, though they lend themselves to easy solution, as will be seen from the following:—

In order to convert a terminate decimal to a fraction it is well known that the decimal part is taken as the numerator and placed over 1 with as many cyphers as there are figures following the decimal part for the denominator; but with interminate or repeating decimals the rule is to subtract the non-repeating portion from the whole of the decimal, the remainder forming the numerator of a fraction, the denominator of which is formed by 9 for every figure repeating and 0 for every figure non-repeating. (It must be remembered that in ratios of one place of decimals with the figure repeating, that same figure can only be from 1 to 8; this applies also to ratios of more than one place of decimals, where the last figure is the only one repeating.)

In working out the table referred to it was noticed that all ratios of three places of decimals, with the three figures repeating (generally called pure circulates), except those commencing with cyphers, are divisible by either 9 or 37, so that for these particular ratios we have a direct method of obtaining the fractional equivalent, which would give us the change wheels necessary for these ratios.

A few examples of recurring decimals are here given with the method of working them out. These have been selected entirely at random and will be quite clear, as the method employed is exactly as outlined above.

Example 43.

Ratio.	Method of applying rule.	Change wheels.
.01	$\frac{1}{90}$	$\frac{15}{135} \times \frac{14}{140}$
.12	$12 - 1 = \frac{11}{90}$	$\frac{15}{75} \times \frac{55}{90}$
.21	$21 - 2 = \frac{19}{90}$	$\frac{20}{90} \times \frac{95}{100}$
.03	$\frac{3}{99}$	$\frac{15}{90} \times \frac{16}{88}$
.005	$\frac{5}{900}$	$\frac{14}{180} \times \frac{14}{196}$
.016	$16 - 1 = \frac{15}{900}$	$\frac{15}{120} \times \frac{20}{150}$
.106	$106 - 10 = \frac{96}{900}$	$\frac{20}{75} \times \frac{40}{100}$
.126	$126 - 12 = \frac{114}{900}$	$\frac{15}{45} \times \frac{19}{50}$
.727	$727 - 72 = \frac{655}{900}$	$\frac{40}{75} \times \frac{131}{96}$
.005	$5 - 0 = \frac{5}{990}$	$\frac{14}{196} \times \frac{14}{198}$
.015	$15 - 0 = \frac{15}{990}$	$\frac{15}{90} \times \frac{15}{165}$
.126	$126 - 1 = \frac{125}{990}$	$\frac{25}{55} \times \frac{25}{90}$
.072	$72 - 0 = \frac{72}{990}$	$\frac{15}{75} \times \frac{32}{88}$
.503	$503 - 5 = \frac{498}{990}$	$\frac{48}{90} \times \frac{83}{88}$
.990	$990 - 9 = \frac{981}{990}$	$\frac{109}{110}$
.009	$\frac{9}{999}$	$\frac{15}{180} \times \frac{20}{185}$
.126	$\frac{126}{999}$	$\frac{21}{37} \times \frac{20}{90}$
.037	$\frac{37}{999}$	$\frac{20}{90} \times \frac{15}{90}$
.909	$\frac{909}{999}$	$\frac{30}{37} \times \frac{101}{90}$
.990	$\frac{990}{999}$	$\frac{40}{37} \times \frac{55}{80}$

Ratio.	Method of applying rule.	Fract'n reduced.	Change wheels.
.1216	$1216 - 1 = \frac{1215}{9990}$	$\frac{9}{74}$	$\frac{15}{37} \times \frac{30}{100}$
.52083	$\frac{52083}{5208} = \frac{46875}{90000}$ (46875)	$\frac{25}{48}$	$\frac{30}{60} \times \frac{75}{72}$
.207317	$\frac{207317}{2} = \frac{207315}{999990}$ (207315)	$\frac{17}{82}$	$\frac{15}{41} \times \frac{34}{60}$
.3109756	$\frac{3109756}{31} = \frac{3109725}{9999900}$ (3109725)	$\frac{51}{164}$	$\frac{15}{41} \times \frac{85}{100}$
.43065693	$\frac{43065693}{99999999}$	$\frac{59}{137}$	$\frac{59}{137}$
.196428571	$\frac{196428571}{196} = \frac{196428375}{999999000}$ (196428375)	$\frac{11}{56}$	$\frac{20}{70} \times \frac{55}{80}$
.2053571428	$\frac{2053571428}{2053} = \frac{2053569375}{9999990000}$ (2053569375)	$\frac{23}{112}$	$\frac{23}{70} \times \frac{50}{80}$

Examples showing the result of adding and subtracting the fractional ratios of increasing or decreasing ratios to or from the fractional elements of the required ratio.

Ratio required, .1234.

Find simple ratio near to this, say,

$\frac{10}{81}$ = .123456 increasing ratio, and

$\frac{9}{73}$ = .1232 decreasing ratio.

Ratio .1234 = $\frac{1234}{10,000}$ and reducing we get $\frac{617}{5000}$.

Example No. 44.	10	81	Ratio.	Nearest to req'd ratio.
	617	5000		
Add	627	5081	.1234009	1
Add	637	5162	.1234017	3
Sub.	607	4919	.1233990	2
Sub.	597	4838	.123398	4

Example No. 45.	9	73	Ratio.	Nearest to req'd ratio.
	617	5000		
Add	626	5073	.123398	2
Add	635	5146	.123396	4
Sub.	608	4927	.1234016	1
Sub.	599	4854	.123403	3

From the above we see that :—

Example No. 44.

By adding an increasing ratio we increase the required ratio.

By subtracting an increasing ratio we decrease the required ratio.

Example No. 45.

By adding a decreasing ratio we decrease the required ratio.

By subtracting a decreasing ratio we increase the required ratio.

We will now proceed to work out all ratios from three places of decimals and upwards, whether repeating or not, by the two following methods :—

Method 1.—To get quickly a close approach to the required ratio, correct to as many places of decimals as given in the required ratio. This plan is applicable to all ratios up to six places of decimals, in many cases up to eight places of decimals, and in some cases up to any number of places of decimals.

Method 2.—The degree of accuracy required may be the principal feature, and should it be necessary to have the nearest possible ratio obtainable to the required ratio, we should have to exhaust that ratio ; that is, try every possible combination to get the best solution obtainable by double trains. This, of course, is a long and tedious operation, but can be shortened, as will be shown further on.

Method 1.—*Ratios of Three Places of Decimals.*

Ratio required .223. This figure being a prime number, will not factorise, so we find the nearest ratio to it, which is $\frac{29}{130}$ = .22307

We next place the numerator and denominator of required ratio in two columns. Now add the approximate ratio numerator and denominator to these as shown.

223	1000
29	130
252	1130

As these two numbers are both factorisable, we work the ratio $\frac{252}{1130}$ out thus :—

Change wheels = $\frac{14 \times 18}{10 \times 113} = \frac{14}{50} \times \frac{90}{113}$ = .223008.

This ratio we will consider as near enough to meet our requirements. It generally happens that this adding together has to be repeated several times before we get either numbers that factorise or that give a result near enough to that required. As an alternative, these numbers, as already explained, can also be subtracted, which gives similar results, and examples of these will be given further on.

Ratios of Four Places of Decimals.

Required ratio, .4513. This number, also a prime number, will not factorise ; consequently we cannot get the exact ratio, so we try for one near to it. We find ratio $\frac{51}{113}$ = .45132.

Adding we get		Subtracting we get	
4513	10,000	4513	10,000
4564	10,113	4462	9,887
4615	10,226	4411	9,774
4666	10,339	4360	9,661
4717	10,452	4309	9,548

It will be seen that the only numbers factorisable are the last ones and these we work out :—

$\frac{4717}{10,452}$ = .451301. Change wheels = $\frac{53 \times 89}{78 \times 134}$

$\frac{4309}{9548}$ = .451298. Change wheels = $\frac{31 \times 139}{62 \times 154}$

We will consider these ratios not near enough for our purpose, so (see examples 44 and 45) it is no good continuing with this approximate result. We therefore find a decreasing ratio, viz., $\frac{37}{82}$ = .4512

Adding.		Subtracting.	
4513	10,000	4513	10,000
4550	10,082	4476	9,918
4587	10,164	4439	9,836

Numbers 4550 and 10,082 will factorise into change wheels $\frac{65 \times 70}{71 \times 142}$, which equals .4512993 As the error in this case is only .0000007 and the error for ratio .451301 is .000001, we will consider this result near enough.

Ratios of Five Places of Decimals.

Required ratio, .30074. This will not factorise, so we will increase the ratio to .30075, which also does not factorise, but will reduce and give us more suitable figures to work upon.

Reducing $\frac{30,075}{100,000}$, we get $\frac{1203}{4000}$. Now, since we have increased our base ratio above that of the required ratio, we know that we must add a decreasing ratio to decrease the base ratio. We find $\frac{43}{143}$ and $\frac{46}{153}$ give .30069 and .30065 respectively, both decreasing ratios. We will try both of these, and adding as shown we get the bottom line in each case to work out as factorisable numbers.

Adding we get :—

1203	4000	1203	4000
43	143	46	153
1246	4143	1249	4153
1289	4286	1295	4306
1332	4429	1341	4459

Trying these, we find $\frac{1332}{4429}$ = .3007450 and $\frac{1341}{4459}$ = .30074007 ; the latter we will consider near enough, and the change wheels will be $\frac{18}{91} \times \frac{149}{98}$.

Ratios of Six Places of Decimals.

Required ratio, .123456 = $\frac{123,456}{1,000,000}$, and reducing we get $\frac{1929}{15,625}$. Since 1929 will not factorise, we cannot get this ratio exact. Ratio $\frac{10}{81}$ = .1234567, proceeding as before :—

Adding we get		Subtracting we get	
1929	15,625	1929	15,625
1939	15,706	*1919	15,544
1949	15,787	*1909	15,463
1959	15,868	1899	15,382

The two examples marked * are the only ones that will factorise, and we already know from examples 39 and 40 that the first of these will give the nearest result.

Working this out we get $\frac{1919}{15,544}$ = .123455995, a ratio which, although not correct to six places of decimals, is probably nearer the required ratio than another that is correct to six places. Change wheels for this ratio = $\frac{19}{116} \times \frac{101}{134}$.

EXHAUSTING A RATIO.

Ratios from Seven Places of Decimals and Upwards.

It is well known that by adding a given ratio to itself for a certain number of times it will eventually give an answer equal to the fractional equivalent of that ratio.

Take ratio .$\dot{5}7142\dot{8}$ and adding thus :—

1	.57142857
2	1.14285714
3	1.71428571
4	2.28571428
5	2.85714285
6	3.42857142
7	3.99999999

Here we find that after adding the ratio to itself for six times we get an answer equal to 4 ; this gives us the equivalent fraction $\frac{4}{7}$, which equals .$\dot{5}7142\dot{8}$.

This answer always works out with a certain number of cyphers or figures 9 following the decimal point, and naturally the oftener these figures follow one another the nearer we approach the required ratio. Now we cannot afford the time to keep adding a ratio to itself in this manner, as in an extreme case this operation would have to be repeated 39,601 times. To reduce the time we proceed thus :—

Take ratio .$2\dot{6}1904\dot{7}$ and make a Table A as shown, multiplying the ratio from one to ten times.

	A.
1	.26190476
2	.52380952
3	.78571428
4	1.04761904
5	1.30952380
6	1.57142857
7	1.83333333
8	1.09523809
9	2.35714285
10	2.61904761
	B.
20	5.238095
30	7.857142
40	10.476190

Looking at this table we see there are no two sets that will add up to .99 or .00, so we start another Table B, multiplying the ratio by 20. Opposite 20 we find we should require .76 to give us an answer. As this number is not in Table A, we multiply the ratio by 30; we find we should now require .14 to give us an answer. This number not being on Table A, we now multiply the ratio by 40. We now find that on Table A, opposite 2, we have a suitable number; so adding these together thus :—

Table A	.. ..	2	.. ..	.523809
Table B	.. ..	40	.. ..	10.476190
Sum	.. .. ..	42	.. ..	10.999999

We get here $\frac{11}{42}$, which equals .2619047, the required ratio.

Now, take ratios .1421433, seven places of decimals; .14214321, eight places of decimals; .142143144, nine places of decimals. We have taken these ratios of similar figures so that one method of working them out will cover the lot, and we will attempt to get the same, if possible, correct to seven, eight, and nine places of decimals. We have worked this ratio out as far as shown in the results obtained; but to save time and space here we will only refer to the working out in a condensed form. In these cases, as the attempt will be a prolonged one, we make a Table C similar to A by multiplying the ratio from one to fifty times. We will condense these tables and only give the actual figures we require for our purpose.

TABLE C.		TABLE D.	
1 ..	.142143144	950 ..	135.0359868
2 ..	.284286288	5,000 ..	.710.7157200
5 ..	.710715720	7,600 ..	1080.2878944
7 ..	.995002008	14,000 ..	1990.0040160
8 ..	1.137145152	14,600 ..	2075.2899024
22 ..	3.127149168	15,800 ..	2245.8616752
49 ..	6.965014056	35,400 ..	5031.8672976

Referring to Tables C and D we find that by adding certain lines in each table together we get the following result, and as all these numbers will factorise we can fill in the required change wheels.

			Ratio.	Change wheels.
	950	135.035986	$\frac{142}{999}$ = .142	$\frac{20}{74}\times\frac{71}{135}$
	49	6.965014		
(a)	999	142.001000		
	5000	710.715720	$\frac{711}{5002}$ = .1421431427	$\frac{18}{82}\times\frac{79}{122}$
	2	.284286		
(b)	5002	711.000006		
	7600	1080.28789	$\frac{1081}{7605}$ = .1421433267	$\frac{23}{39}\times\frac{47}{195}$
	5	.71071		
(c)	7605	1080.99860		
	14000	1990.004	$\frac{1991}{14007}$ = .1421432141	$\frac{22}{161}\times\frac{181}{174}$
	7	.995		
(d)	14007	1990.999		
	14600	2075.2899	$\frac{2076}{14605}$ = .1421431016	$\frac{12}{115}\times\frac{173}{127}$
	5	.7107		
(f)	14605	2076.0006		
	15800	2245.8616	$\frac{2247}{15808}$ = .1421432186	$\frac{21}{104}\times\frac{107}{152}$
	8	1.1371		
(h)	15808	2246.9987		
	35400	5031.867297	$\frac{5035}{35422}$ = .1421433007	$\frac{53}{178}\times\frac{95}{199}$
	22	3.127149		
(L)	35422	5034.994446		

Taking these results in order, the first (*a*) being a self-evident repeating decimal, we see that the ratio will be the numerator as a repeating decimal; (*b*) is the nearest we can get to the ratio of nine places of decimals (it is only correct to eight places of decimals), but the ratio being triplicate numbers advancing by unity, makes it an awkward ratio to obtain; (*c*) and (L) are correct to seven places of decimals; (*d*) and (*h*) are correct to eight places of decimals; (*f*) is a case, which sometimes crops up, of a number which will factorise and also approaches one of the required ratios; but we cannot make use of the same, seeing that one of the factors, viz., 12, is a number for which we have no change wheel, and we cannot obtain another number to replace it by altering any of the other wheels in the train.

FINDING A MEAN RATIO BETWEEN TWO GIVEN RATIOS.

We might require change wheels for a ratio exactly halfway between two others. For instance, take the two ratios $\frac{51}{113}$ = .4513274336 and $\frac{41}{79}$ = .5189873417. The mean of these is .4851573876. A simple way of doing this is to bring the two denominators to the same figure by cross multiplying thus :—

51 × 79 and 113 × 79 = 4029 and 8927.
41 × 113 and 79 × 113 = 4633 and 8927.

The mean of 4029 and 4633 is 4331, giving the fraction $\frac{4331}{8927}$, which gives the required ratio, and we find these numbers factorise thus :— $\frac{61}{79}\times\frac{71}{113}$, which gives us the change wheels we require. If these numbers do not factorise we should have to approximate to them, as explained previously.

INCREASING OR DECREASING RATIOS.

A ratio can be increased any number of times by multiplying the numerator of its equivalent fraction, and at the same time the ratio itself by that same number.

Example.—Ratio $\frac{5}{8}$ = .625; multiplying by 5 we get $\frac{25}{8}$ = 3.125, and change wheels = $\frac{50}{30}\times\frac{75}{40}$.

Similarly, a ratio can be decreased any number of times by multiplying the denominator of its equivalent fraction, and at the same time dividing the ratio by that same number.

Example.—Ratio $\frac{41}{79}$ = .518987 +. Multiplying the denominator by 2 and dividing the ratio by 2 we get $\frac{41}{158}$ = .259493 +.

Keeping the decimal part of any ratio the same and placing the number in front of the decimal point. This comes in useful when getting out change wheels for cutting tapers in the lathe. These tapers are generally given as so much per foot or as 1in., say, 3.128753.

Example.—Take ratio $\frac{7}{8}$ = .875. Now, whatever number is required in front of this ratio we multiply that number by the denominator of its equivalent fraction and add the result to the numerator, keeping the denominator the same. Thus:—Required ratio, 4.875. Then 4 × 8 = 32 and 32 + 7 = $\frac{39}{8}$. Change wheels = $\frac{65}{30}\times\frac{90}{40}$.

Example.—Take ratio $\frac{103}{123}$ = .83739. Required ratio 5.83739. Then 5 × 123 = 615 + 103 = $\frac{718}{123}$. This number will not factorise, but we find $\frac{36}{43}$ = .8372; converting we get $5\frac{36}{43}=\frac{251}{43}$; adding this as shown

718	123
251	43
969	166

we get factorisable numbers which give a ratio of 5.83734, and as this is less than the required ratio it is no use trying further, as adding a decreasing ratio only decreases the result still more.

Now, it is self-evident that multiplying a fraction by any number does not alter its ratio, but the addition of 43 and 251 to the increased numbers will give nearer results to the answer we require. For instance, multiplying by 9 we get—

6462	1107
251	43
6713	1150

and adding the numbers 43 and 251 gives us factorisable numbers which work out to 5.837391. This is not near enough, so we multiply the numbers again by 18 and proceeding as before get factorisable numbers

12,924	2214
251	43
13,175	2257

which gives us a ratio of 5.8373947. For the present we will consider this near enough, but by multiplying by still greater numbers we should probably come across another ratio nearer still to the required ratio.

IN a lecture prepared by Mr. Percy Pritchard for the Institution of Automobile Engineers, the author suggests that young automobile engineers possessing sound engineering knowledge and fully acquainted with modern foundry practice should be encouraged to take up the profession of foundry engineers, a branch in which there is great demand and no supply. Such men would act as connecting links between makers and users of castings, advising the users as to what would be the cheapest and most successful design, and assisting the foundry to solve some of their many problems.

Institution of Mechanical Engineers.

AN extra general meeting of the Institution of Mechanical Engineers took place on Friday evening last, when Mr. R. W. Wilson, of Newcastle-on-Tyne, read his paper on "Repair and Upkeep of Pneumatic Tools." The President of the Institution, Sir John Dewrance, took the chair. The occasion was of perhaps more than usual interest, for Mr. Wilson's paper—which we publish elsewhere in this issue—is the first on this subject which has been read before the Institution since Mr. Ewart C. Amos's paper on "Portable Pneumatic Tools," of February 22nd, 1900. This last-named paper gave a complete account of the principal pneumatic tools of that date, and it was reprinted in THE ENGINEER of March 23rd, 1900, and the issue following.

The discussion on Mr. Wilson's paper was opened by Mr. Frank Hills, of the Globe Pneumatic Engineering Company, Limited, who made reference to the author's statement "that pneumatic tools must be rough and strong externally, so that they can withstand the most strenuous use and unlimited abuse." The word "rough," the speaker said, might fittingly be replaced by "rugged." With regard to air leaks, there was a source of leakage which he had discovered when making a series of tests on the Continent some three years ago. This was the leakage over the throttle valve when the hammer was working. It could be determined by connecting the hammer to be tested with an air meter, and pressing the trigger after plugging all the outlet holes. For the repairing of pneumatic tools, a good fitter was undoubtedly the best man for the job. The author had referred to drop in air pressure caused by hose couplings. This, Mr. Hills thought, might often be explained by the use of self-closing hose connections, which made it difficult to keep up the air pressure at the tool. Figures had been given with regard to costs of upkeep. It would be well to include in such returns the amount of air consumed per minute and the amount of metal removed, or the air used per rivet or per "crush" when testing was carried out. It was with regret that he noted that little was said in the paper presented that evening on drilling machines and means of testing them. He was of the opinion that the best test for drilling machine research work was a plain brake test, which eliminated the uncertain personal element of the amount of feed given to the drill. Mr. Hills recommended a simple rope brake, using such an apparatus tests made on the same tool at an interval of six months had only showed about one hundredth of a horse-power in difference. With compound drilling machines for heavy reaming work, reliable tests were difficult, as about 2 horse-power was being transmitted at a speed of 50 revolutions per minute. The brake test was sound, and it checked well with the drilling tests. A disadvantage of the crushing test for hammers was that it was expensive and demanded considerable accuracy in making the test pieces; unless these were made to fine limits and normalised for hardness, the results given would vary. With reference to the speed of a hammer and the number of blows delivered per minute, a rapid and fine sounding hammer was often preferred by the uninitiated buyer to the more efficient and better-powered slow-running machine. In chipping with a fast-running hammer, much power was lost in heating up the chisel and chip. Actual curves were shown by Mr. Hills representing the results of low-pressure crushing tests made at 65 lb. per square inch pressure and test pieces of 40 tons tensile material and a Brinell hardness No. of 170. They were generally in accordance with the results given by the author in his paper.

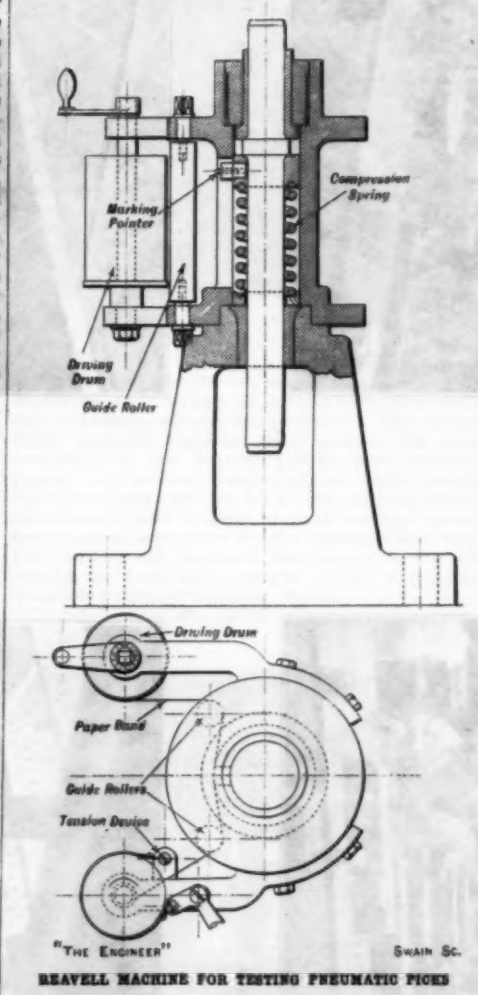
Mr. T. Hornbuckle, representing Sir Henry Fowler, said that the value of the paper lay in the definite information it gave as to the cost of using and repairing pneumatic tools. Few users, he supposed, were in a position to give such information. With regard to Mr. Wilson's figures for the cost of power, he thought that they were extraordinarily low. The system of making a workman personally responsible for the tools he was using was excellent in every way. Referring again to the cost of power, he would like to know whether the figures presented took into consideration any governing arrangement, in which there was churning of air, or were the motors driving the air compressors of the variable speed type? Further particulars might with advantage be given concerning maintaining in repair flexible hoses and hose connections, as unless these parts of the installation were kept in good condition, the air lost in leakage would be found to be a high percentage of the total air produced. For the testing of drills in the repair shop, he had found an arrangement of gears attached to a Morse taper spindle useful. The drill to be tested was coupled to an air meter, and good comparative results were obtained. In drilling the proportion of the size of drilling machine to the size of drill used was very important.

Mr. S. E. Thornton, of the Howard Pneumatic Engineering Company, Limited, thought that hardly sufficient stress had been laid on the wastefulness and extravagance of leaking joints. It was the duty of the manufacturers to make drills and tools that would use the minimum amount of air. In many cases, air blew from every joint, and this fact should

be given attention. The author had described an interesting form of test apparatus. In making tests it would be useful to have a National Physical Laboratory standard of comparison. In Mr. Ewart C. Amos's paper on "Portable Pneumatic Tools," read before the Institution twenty-four years ago, speaking of a certain drill, it was said that it was capable of boring a hole 1in. in diameter and 1in. deep in the course of from two to three minutes. Nowadays, the same operation might be performed in about half a minute. Wages to-day were approximately 30 per cent. higher and the initial cost and maintenance of the tool was 50 per cent. lower. Therefore, with a time of one-quarter of the former time, the saving to-day was considerable.

Mr. W. G. Corner, of the Ingersoll Rand Company, Limited, said that the later speakers had spoken but little on the important subject of works upkeep cost. Was the question of upkeep receiving the attention it deserved? Pneumatic tools received abuse in more senses than one. After all, it was a question of putting horse-power into the workman's hands, and a pneumatic drill weighing only some 40 lb. and consisting of a 2 horse-power motor and all the essential parts of a drilling machine needed more attention than, say, a ratchet brace. The work performed by such a tool was five or six times that which could be performed by hand. He doubted the advisability of the bath of paraffin, or similar oil, for cleaning. There was no surplus oil to be removed, but usually water, and did paraffin remove that? After examining the blackened and pitted faces of valves and internal parts, he had formed the conclusion that the aerated water attacked these parts when the hammer was not in use. The immersion in oil was a survival from the early days when there was reluctance in dismantling the tools. Makers should design tools which were readily accessible, so that the working parts could easily be removed and cleaned. For efficient working clean and high-pressure air was absolutely necessary; 90 lb. to 100 lb. air pressure was an efficient figure. Dry air was assured if proper receivers and piping were installed. The function of the receiver was not only to store the air, but also to cool it and serve as a means for depositing the moisture. The author had referred to the method of cleaning the air strainers by blowing air through in the reverse direction. A more frequent shop method was to make a hole in the gauze by means of a scriber or centre punch! The appointment of a man to do nothing else but search for and repair leaks and lubricate the tools would be found to yield a considerable return in savings made. Much air was wasted by using larger drills than were necessary for given work. With ordinary work it was practically impossible to overload a drill; but underloading was often the cause of serious trouble. If a 1¼in. drill were used on ½in. holes, the air motor would tear round, and the whole operation might be compared with that of running a motor car in low gear continuously. Some form of governor to prevent racing at light load and no-load would be a distinct improvement.

Mr. William Reavell, Vice-president, said that he welcomed this paper, which came twenty-four years after the last paper on pneumatic tools, read by Mr. Ewart C. Amos. A great deal had been done to improve the design of these tools in the intervening years, and the present paper might well form part of a symposium on pneumatic tools of all kinds. In recent years other machines using compressed air had been adopted in the form of air hoists, foundry machines and concrete-breaking machines, and the field for such a symposium was a wide one. The author had given figures for the cost of upkeep. Certainly an effort should be made to reduce upkeep costs. The figures given in the paper would be more informative if another column was added showing the number of hours each tool was worked, and some idea given of the cost per hour worked, or per 100 hours worked. Much could be said on the subject of air leakage. Hose line connections and tools were often badly used. Indeed, the pneumatic tool might well be likened to Dickens' Marchionness—badly fed, badly dressed, and expected to work at all hours. At Ipswich it was usual to examine all pipe lines and air connections once a week in the silence of a meal hour. Any leakage was listened for, leaks marked, and afterwards repaired. Unlike steam leaks, air leaks could not be seen, and they were best detected by sound. Silence was necessary if a thorough investigation was to be made. Drop in pressure was caused by the same small leaks which, in time, had a tremendous effect on efficiency. In a recent example of ⅞in. riveting on a vertical tower, it was noted that the work done became worse and worse as the height of the tower increased. That was caused by the use of inadequate air connections, causing a drop in pressure from 90 lb. per square inch at the compressor to 45 lb. at the tools. A large number of tests had been made at Ipswich on the losses caused by friction in pipe lines. In most cases such loss was to be directly attributed to cheap and inferior fittings and connections of too small a diameter. With regard to the cost of producing compressed air, too often the efficiency of the compressor was neglected, and price became the chief factor in the decision. If a compressor was properly rated and suitable for its work, less cooling water was used and the air delivered was cool, giving better working. Speaking of testing machines, particulars might be given of a testing machine for pneumatic picks for coal mining which had been developed at Ipswich. The object of this machine was to measure the force of the blow, and, at the same time, the number of blows per minute. It is illustrated diagrammatically in the sketch. The hammer blow is directed on to a tup, which slides in guides and serves to compress a strong spring. Beneath the guiding collar is a loose collar, to which a pointer, projecting just beyond the outer surface of the casing, is attached. This pointer moves in a slot and serves to indicate the amount by which the spring is depressed. Two rollers, on which are wound a paper band, and further guide rolls to direct the paper in the path of the pointer, are provided. When the machine is in operation and the paper is moved across the pointer, a diagram is given which shows by the amount of vertical movement of the pointer and the space between successive movements the strength and duration of the blow. This machine has given good results. Turning to the figures—Nos. 3 and 4—given in the paper, Mr. Reavell asked whether the tools were of the same rated capacity; that is, of the same piston diameter and length of stroke, or whether the differences in rating were



REAVELL MACHINE FOR TESTING PNEUMATIC PICKS

allowed for by calculation. It was satisfactory to note that the British tool gave by far the best results.

Mr. Frank Hills, in reply to a previous speaker, stated that as far as he was aware a continental make of tool was on the market which was fitted with a governing device, making it self-regulating.

Mr. W. H. Patchell, Vice-president, referred to a previous attempt to get a symposium on compressed air tools. At that time makers and users were uncommonly shy in coming forward. There was definite value in taking and tabulating results. An interesting point was the use of pneumatic tools in tropical countries. There were great drawbacks to the use of such tools in China, for instance, on account of the weight of the tools. It was highly important that makers should design lighter tools for use in the East. Foundry tools had not been mentioned. Pneumatic tools did not create unemployment, but distributed the work better.

Mr. N. R. Redfern, Associate Member, spoke as a potential buyer and user of pneumatic tools. He was interested in their use with native labour in the Tropics. When considering the advisability of installing such tools in an African shipyard, he found that two shipyards in the same locality had put in compressed air plants, but had used them very little on account of the difficulty of obtaining tools which might easily be worked by native labour. If such a tool was produced there was a world-wide field for it.

Mr. R. W. Wilson, replying to the discussion, stated that so many questions had been raised that he would deal with some and leave others over for the adjourned discussion. He agreed with what Mr. Hills said concerning the rugged character of the tools. The word "rugged" was certainly better than the word "rough." Self-closing couplings certainly tended to throttle the air and cause loss in efficiency. They might save air in some cases, but where the tools were fixed they were not of such great service. He proposed to leave over the question of testing of drilling machines. Mr. Hornbuckle had mentioned the question of leakage and its cost. Compressed air, it might be considered, was very nearly as expensive as gas, and the "cheery fizzle" often heard might be very costly. Often one-third of the output of compressed air was lost in leakage. It was advisable to sectionalise all pipe lines, and to meter each section when no tools were working. With regard to tools for native labour, the difficulty was more often that of timidity rather than weight. The men were frightened to use the tools. On the Rand the practice was in the direction of increasing the weight of the tools, and heavy rock drills served by two natives were now being used. It had given both pleasure and instruction to prepare the paper, and he trusted that the result would be that more interest would be created in the use of compressed air.

Sir John Dewrance, President, announced that an opportunity for the further discussion of this paper would be given at the next general meeting. He said that pneumatic tires had always been associated with the relief of shock, but pneumatic tools could not be separated from the idea of shock and jarring. Could nothing be done to alter that? He thanked the author for his excellent paper.

Considerable interest was displayed in the actual testing machine, sample test pieces, and parts of pneumatic tools which were inspected after the termination of the meeting.

Training of Aircraft Apprentices at Halton Camp.

No. III.*

TECHNICAL TRAINING.

Of the School of Technical Training alone, volumes might be written. In all, it covers an area of some 575ft. by 525ft., and is made up partly of a series of well-lighted bays, with saw-toothed roofs, and partly of separate rooms which are used for lectures and oral instruction. The school might well be termed a miniature engineering works. It is well equipped with all the machinery likely to be employed in maintaining and keeping in repair aircraft of all kinds. There are, of course, no very large machines of any kind, but of smaller machines there is a great variety, and at practically all of them there are working youths in varying stages of training, many of whom we saw producing work of practical value, which would subsequently find its way into the structure of aeroplanes or their engines. Then there are riggers', carpenters', coach and body building, acetylene welding, blacksmiths', coppersmiths' and whitesmiths' departments, as well as shops for fitters of various classes, fabric workers, &c. Some of these are illustrated in our Supplement, while views of others are given in Figs. 8, 9 and 10 on page 168. The photographs from which all were reproduced were taken by Gale and Polden, Limited, of Aldershot. In all of these departments excellent work was being done under what must certainly be described as expert direction, though it should be said that the directors did not make themselves specially prominent. They were dressed exactly as were the lads they were instructing, and mingling with them they were, at a distance, only with difficulty distinguished from their pupils. There was evidently an excellent feeling existing between instructor and student, and, we were greatly struck by the earnestness evinced by all the apprentices who came under our notice. We were permitted to wander alone through the various departments, unaccompanied by a "chief," whose appearance might give the signal for the assumption of energy—anyone who has "been through the shops" will know what we mean—but we saw no signs whatever of any slacking.

We do not propose to describe fully the different departments, but special mention may be made of a couple of them. One of the bays is occupied by a series of aeroplanes—both British and foreign—in various stages of dissection, so that their construction and internal arrangement may be readily studied—see Fig. 11. This department certainly offers an excellent opportunity to the student to make himself acquainted with the characteristics of the leading types of flying machines at present in use. Another department is devoted to the study of aeroplane engines of different designs. The apprentices are taught how to dismantle and re-erect the engines, and subsequently to submit them to running tests, the latter being conducted in shelters built outside the school.

The heating of the Technical Training School

* No. II. appeared February 8th.

HALTON CAMP TRAINING CENTRE FOR AIRCRAFT APPRENTICES

FIG. 8—FITTERS' SHOP

FIG. 9—FITTERS—AERO SHOP

FIG. 10—FITTERS - DRIVER - PETROL SHOP

FIG. 11—AIRCRAFT MUSEUM

is effected by means of hot air driven through galvanised sheet steel ducts suspended from the roof. The air is warmed by drawing it by fans over coils which are heated by the steam from a battery of five boilers which are housed in a building which adjoins the power-house, to which we shall refer later. We understand that this heating system, which was installed at a time when use had to be made of anything which could be obtained, whether it was the most suitable or not, is not as efficient as it might be, and the question of replacing it is now under consideration.

RECREATIONS.

While the mental and manual training of the lads is rigorously carried out, their physical well-being is by no means lost sight of. There is a well-appointed gymnasium, and there are playing fields, and the playing of games of all kinds is greatly encouraged by the authorities. The judicious mingling of work and play has, evidently, an excellent effect on the physique of the youths. A healthier, better set-up and cleaner looking set of youths it would be hard to find.

FIG. 12—TECHNICAL LIBRARY AND READING ROOM

As a further means of providing entertainment, recreation and opportunities of self-instruction, there have been provided two "Regimental Institutes"—one to each block of eight dormitory buildings. Only the structure of these buildings was carried out by the Air Force itself, the furnishing and equipment having been effected by the Navy, Army and Air Force Canteens Board, which body also makes itself responsible for the running of the Institutes. The lower floor of each Institute is taken up by a well-equipped kitchen and by a large room for the boys, in which are numbers of small tables, a separate corporals' room, staff quarters and lavatories, &c. The apprentices may obtain any additional food which they may consider they require, at very reasonable rates, and can play such games as chess and draughts at the tables. The upper floor contains a large billiard and games room—see Fig. 13—and a reading room and library—see Fig. 12. The latter is well stocked with books of all kinds, including not only works of fiction, but others of a much more serious nature. We noted, for example, several on the differential and integral calculus, which had evidently been handled. On the same floor are also writing-rooms to hold only two or three at a time, so that letters can be written, or special work done, in privacy as great as that enjoyed by the large majority of public school boys.

These Institutes give the visitor the idea of being exceptionally well managed, and they should prove of very considerable value to the apprentices. We understand that the Air Force has no say either in their conduct or finances, but that they are run by the Canteens Board and run at a profit, of which a proportion—we believe 10 per cent.—is handed back to be credited to the regimental funds.

HOSPITALS.

In addition to the surgeries and dispensaries in the special blocks, to which reference has already been drawn, there are two hospitals, one for ordinary and one for infectious cases. With regard to the latter, we believe we are right in saying that it has had very few occupants since the system of training apprentices was started at Halton Camp.

LIGHTING.

The electrical energy which is used for lighting the camp and for driving the various motors which are employed for various purposes is generated in a building near the west corner of the School of Technical Training. It contains four separate generating sets, each driven by a Diesel engine, of which the following are particulars:—One 200-kilowatt four-cylinder engine, direct-coupled to a compound direct-current generator running at 210 revolutions per minute; one 200-kilowatt six-cylinder engine, direct-coupled to a compound direct-current generator running at 230 revolutions per minute; two 100-kilowatt three-cylinder engines, direct-coupled to compound direct-current generators running at 250 revolutions per minute. There is also a 1000 ampère-hour battery, complete with battery booster and milking booster. End cell regulation is employed in conjunction with a remote control battery switch, which can be operated either by hand or automatically arranged to cut cells in or out by variation of the bus-bar voltage. Two rotary balancers, each capable of dealing with 50 ampères out of balance current are provided. The switchboard contains eighteen slate panels, 7ft. high, consisting of two battery panels, four generator panels, two balancer panels and ten feeder panels, the whole being 32ft. 6in. long. The milking booster switchboard and remote control battery switch are mounted separately on the battery room wall. For carrying out overhauls and repairs to the sets there is an 8-ton hand-operated crane, which runs the whole length of the power station.

Distribution is effected by means of a three-wire direct-current system at a pressure of 460 volts across the outers. There are overhead conductors to the School of Technical Training and to adjacent buildings, as well as a few main feeders. These latter will give place to underground cables as replacement becomes necessary.

The feeder going to the Boys' Camp forms one leg of a ring main eventually to be provided as the accommodation required develops. The buildings at Bulback Covert are fed from this main by means of a subsidiary ring main, with disconnecting boxes in each building. The wiring of the buildings is all carried out in screwed conduits.

Some words of praise regarding the excellent running and the condition of the machines in the power-house are certainly called for. They left nothing to be desired. Although some of the machinery was installed at a time when engines and generators of all kinds were hard to get, and though some of them were made under the stress of war, they did not evidently suffer in quality on that account. We were informed that though some of the machines have been running for five years, no commutator has had to be trued up, and there was no sign whatever of either wear or sparking.

The cooling of the jacket circulating water is effected in a pond adjacent to the power-house, and the circulation of the water is brought about by two centrifugal pumps, each capable of delivering 12,000 gallons per hour against a total head of 25ft. The pumps are driven by 3.5 horse-power electric motors, running at 1300–1500 revolutions per minute, and are sunk below the level of the cooling pond. The starting panels are situated in the engine-room close to the pump-room door.

The full load consumption on the 200-kilowatt 6-cylinder set works out at 0.625 lb. per kilowatt hour, while that of the 100-kilowatt 3-cylinder set was 0.683 lb. per kilowatt hour. The consumption test on the 4-cylinder 200-kilowatt set varied between 0.626 lb. and 0.636 lb. per kilowatt hour at full load.

We may here mention that for the purpose of bringing fuel and other supplies into the camp there is a standard gauge line which makes a junction near Wendover Station with the line to Aylesbury, jointly owned by the Metropolitan Railway and the Great Central Section of the London and North-Eastern Railway. A branch of this camp line runs alongside the power-house and the boiler-house, to which reference is made elsewhere. The line was extremely useful in bringing materials, &c., to the site during the construction of Bulback Barracks. At the present time the line is only licensed for goods traffic, though it is hoped that in the near future the Board of Trade may be induced to sanction the conveying of passengers by it.

NUMBER OF APPRENTICES.

At the time of our visit there were under training a total of 1352 apprentices, that number being made up as follows:—Fitters (including "Fitters A-E," "Fitters-driver-petrol," and "Fitter-armourers"), 890; carpenters (including carpenter-riggers and a small number of motor body builders), 327; coppersmiths, 35; turners, 100; total, 1352.

At the present moment we believe that the number reaches more than 1950, for there have been added 80 machinists, 35 blacksmiths, 380 fitters A-E, and various other trades. These numbers would eventually have been too small even for the requirements of the Service before the recently made decision to increase its scope was arrived at. Plans had, therefore, already been made for the erection of barracks to accommodate the same number as do the Bulback Barracks described in the foregoing. The effect of the proposed increase in the Air Force will, undoubtedly, be that more apprentices, and, consequently, additional barrack equipment will be required.

FIG. 13—RECREATION ROOM

CONCLUSION.

In conclusion, we may say that we were particularly struck with the efficiency with which the whole establishment was evidently being conducted. It is true that in the older parts—as, for instance, the school of technical training—the heating system is not as efficient as it might be, but it was, as explained, installed at a time when there was no chance of a choice; anything which could be obtained had to be employed. In the plant for heating the new

barrack buildings, on the other hand, every possible means of conserving heat has, apparently, been taken advantage of.

Finally, we desire to express our indebtedness to all the officials and staff of the Air Ministry with whom we came into contact for the courtesy which we experienced from them, and for the valuable help which they gave us during the preparation of the foregoing article.

Literature.

Studies in Tidal Power. By NORMAN DAVEY. Constable and Co., Limited. 32s. net. 255 pp.

MR. DAVEY has written a book which will be read with interest by many people, not only engineers, but also those without any pretence to expert knowledge, who take a keen interest in a problem which possesses a certain fascination. There is no doubt that the utilisation of tidal power in the production of energy on a large scale is, in the present state of our knowledge and of the resources which are available to engineers, somewhat in the nature of a vision. In days to come, possibly not at a very remote date, the utilisation of the tides in the production of power may be brought within the ambit of practical engineering and commercial actualities. In the meantime, Mr. Davey has brought together in the compass of one volume information which should be carefully studied by those who have any dealings with tidal power projects.

In his preface, the author writes: "It seems to be my lot, as a writer in applied science, to appear as the champion of lost causes," and although throughout the book he says most of what can be said in support of the cause he has at heart, he does, in his concluding chapter, somewhat temper his own enthusiasm. Thus: "It may be, therefore, that I have in these foregoing studies been led at times to make out too good a case for the exploitation of the power of the tides; so that it may not be out of place, perhaps, in conclusion, to throw a little cold water in the face of the enthusiastic," and he proceeds to point out that the saving in coal consumption if *all* the tidal power available in the United Kingdom was exploited would be only about 6½ per cent. of the yearly output from the collieries. Before leaving Mr. Davey's preface, attention may be called to the words in which the author reiterates "the caution expressed in Chapter VIII. in respect to the tentative character of the estimated costs detailed in that chapter. The citation of unit prices in these changeable times is an uneasy business." We have looked through some of the estimates to which Mr. Davey refers, and undoubtedly his warning note is not uncalled for. His estimates purport to be based on present-day prices, which he takes as equivalent to from 50 to 70 per cent. over pre-war prices. The insufficiency of many of the items is, however, at once apparent to anyone acquainted with the cost of public works at the present time. Moreover, the estimates are in many ways not complete. For instance, in his estimate for a tidal power scheme at Barrow, which he believes would supply 160 million Board of Trade units per annum, Mr. Davey's price for the entrance gates and basin entrance works which will be used by shipping is £7500—an altogether inadequate amount. His rate price for concrete work in this and other estimates for tidal power schemes, which apparently includes excavation and all other charges, is taken at 35s. per cubic yard. In the case of his Salcombe scheme, a sum of £2200 is regarded as sufficient to provide a basin entrance and pair of ship entrance gates. These instances, taken at random, give rise to suspicion as to the adequacy of other portions of the estimates of cost which are given in Chapter VIII.

In an introductory chapter, the author outlines the four systems which have from time to time been suggested for utilising tidal power. He describes these as the float, the tidal stream, the compressed air, and the basin systems respectively, and goes on to show that the basin system alone offers possibilities for the practical utilisation of tidal power. In subsequent chapters, such subjects as the tidal phenomenon, the theory of the tidal basin system and the application of theory to practical conditions, storage arrangements and the mechanical and electrical plant necessary for the conversion of tidal power into electrical energy are dealt with in some detail. These chapters are followed by a general survey of the tidal power available in the British Isles, with tabulated particulars of many localities where, in the author's view, tidal power development is possible; but the data quoted is of necessity meagre and obviously insufficient to enable any opinion to be formed as to the practical suitability of any given site. In this chapter the author refers somewhat summarily to the question of interference with shipping interests. He makes a brief mention of the danger of silting below a tidal dam which has been anticipated in the case of the Severn barrage project, but he entirely ignores the very important question of siltation above the site of the impounding dam, a matter which merits very serious consideration in many situations where tidal and river water heavily charged with matter in suspension has to be taken into account. In the case of the Severn project, which in one form or another has been prominently before the public during the past few years, these questions of silting above and below the barrage and the effect of interference with the tidal *régime* on the navigation channels in the vicinity of the works, and even as far away from the site as Avonmouth, have not, in our opinion, received the attention which they demand.

There is another difficulty not directly connected with the power question, but which attaches to the large majority of the sixty-six schemes relating to particular localities which the author indicates in sketch plans forming an appendix to his work. We refer to the question of land drainage. Mr. Davey does not appear to have given any consideration to the discharge of land drainage, which in many cases would be affected by the construction of the tidal barrages which he indicates in his plans.

The author provides in his chapter on the tidal phenomenon a useful summary of the general characteristics of the tides, but in describing a curve of the sine type as representative of the tidal curve, he overlooks the serious divergence from such a curve which is exhibited by the actual tidal curve, particularly in such situations as the Bristol Channel, where large tidal ranges are met with. In a subsequent chapter containing particular examples of tidal data, the author quite correctly points out that the height of high water in a long tidal estuary is not necessarily at the same level above a constant datum throughout the whole distance of tidal propagation, and mentions that, in general, estuaries, having narrow inlets combined with a considerable area of water surface above the inlet, the level of high water is frequently higher at the entrance than at the head of the tidal compartment, and that, conversely, in tidal rivers which are funnel-shaped in plan, with wide entrances, the height of high water frequently increases with the distance from the mouth. But in his use of the tables which he gives in illustration of these phenomena, he falls into serious error. He quotes from the Admiralty "Tide Tables" the heights of mean high water spring tides at various positions in particular estuaries, inferring that the figures given represent the variation in level of high water, or, in other words, the slope of the high-water line, but he has, in fact, misread the "Tide Tables." The figures given in the Admiralty tables are the spring rises above the (low water) datum of the largest scale Admiralty chart covering the particular locality. Thus, in the figures given on page 69 for the Humber estuary, a series of six levels, ranging from Grimsby to Goole, appears as indicating a decrease in the high-water level of 7.1ft. between these two points. As a matter of fact, the datum levels to which the six figures are referred, vary as much as 6.08ft., and the level given for every one of the six positions is referred to a different datum. The Goole high water is actually only 1.8ft. lower than the high-water level at Grimsby. The same criticism applies to most of the other lists of tide levels which the author quotes. This error seriously detracts from the value of the conclusions which are drawn by the author.

In discussing the theory of the tidal basin system, Mr. Davey shows first of all the total amount of potential energy which is stored up in filling a tidal basin of uniform area under a given tidal range, and then proceeds to deduce the proportion of this energy theoretically available under various systems of working; for instance, constant head with outward flow only, variable head with outward flow only, inward flow systems under constant and variable heads, and mixed flow systems, all in conjunction with a single tidal basin. He then deals with multiple basin systems of various types. For most of his calculations he assumes a straight line tide curve and shows that the error introduced by this assumption, as compared with the sine curve previously assumed, is comparatively small. These theoretical calculations are of considerable interest, and are well presented in the author's pages. It must, however, be admitted that the various assumptions made, while probably justifiable for the purposes of comparison, may be expected to produce results which differ materially from those likely to be attained in actual practice.

In the course of his practical application of the theoretical formulæ which he has evolved, the author refers to the limiting effect of sluice gate areas and assumes a head of 6in. as sacrificed at the sluice gates, making the somewhat optimistic assumption that the whole of this head is available for producing velocity through the sluices, or, in other words, that the coefficient of discharge of the sluices is unity. Further, in his study of storage arrangements and the efficiency likely to be obtained, the author assumes an efficiency of 80 per cent. for centrifugal pumps, inclusive of all pipe line losses. This assumption is certainly an optimistic one. Chapter VIII. is devoted to a brief description of the power plant suitable to the special conditions of tidal power schemes and the type of turbine best adapted for low heads is discussed, together with the various methods of working when an alternating current distribution system is required. This section of the book concludes with a brief description of a power plant and tidal barrage which the author suggests as suitable for the river Avon at Avonmouth, sketch sections and elevations of the proposed dam being shown. The level indicated in the sections for the inflow gates appears to be somewhat extraordinary, and the provision of a single pair of navigation gates, with a clear opening of, apparently, 35ft., does not strike the reader as being sufficient to meet the requirements of the Port of Bristol. The author proposes that these gates should be opened during the last three hours of the flood tide only, and the difficulties which would have to be faced by a ship entering or leaving by such an entrance in the conditions of current which would obtain do not seem to be appreciated by Mr. Davey.

With regard to the Severn Estuary scheme, the author describes at some length that version of it which was evolved by the Ministry of Transport in 1920, and also describes the Aber-vrac'h scheme of the French Government. With regard to the former the author is not enthusiastic. "The Severn scheme, it must be confessed," he says, "was ill-timed, not too well considered and announced to the public in a manner little calculated to bring credit to its promoters. It was foredoomed to defeat." Mr. Davey then proceeds to elaborate several power projects, which appear to be of his own devising, more or less detailed particulars being given for such schemes at Salcombe, Fleetwood and Barrow. The Salcombe scheme may be regarded as a proposal for a small-scale experiment having an estimated output of 14 million Board of Trade units per annum as compared with the 1360 millions of the Severn scheme. Mr. Davey's Salcombe scheme is, therefore, more or less comparable with the French scheme for the Aber-vrac'h estuary, which is estimated to produce 8 millions of units a year. The Fleetwood and Barrow schemes are somewhat more ambitious; the former would have an output of 52 millions, and the latter of 160 millions per annum.

We have already referred to the estimates of cost which the author puts forward, and it is upon these estimates that he bases the figures representing the cost of current which he anticipates will be realised. It is not too much to say that these estimated costs of construction are likely to be very considerably exceeded if any of these schemes are ever carried into effect.

Mr. Davey concludes his survey of the subject by an attempt to compare the probable cost of power from tidal sources with the cost of steam stations of varying sizes and working under varying conditions, and a discussion of the economic aspects of intermittent and variable power. It must be admitted that in view of the somewhat meagre data upon which his estimates of the tidal schemes are based the case for these is not convincing. He summarises his view of the economic question in the following words:—"The general economic aspect of the tidal power problem may be broadly summed up as follows. In all cases where intermittent power may be efficiently employed, tidal power seems to be far more economically advantageous than any other form of power at present available. In such industrial operations as demand a continuous power output over definitive periods, so that storage of power is necessitated, the best tidal power installations would seem to be economically a little below the best, medium-sized central steam stations, where the load factor approaches 100 per cent. In all cases however, where the lower and more usual industrial load factors prevail—i.e., load factors of from 15 to 35 per cent.—the economic advantage lies very strongly with tidal power as opposed to steam power." It is, perhaps, pointing the obvious to say that if manufacturing processes could be adapted to the use of intermittent supply and varying power, the case for tidal power stations would thereby be greatly strengthened.

Whilst the book is open to serious criticism in points of detail and the somewhat rash assumptions made by the author detract from the value of his conclusions, it is, at the same time, an interesting attempt to visualise the possibilities of tidal power development, and, if only for this reason, it is to be commended.

We should, perhaps, add that the sixty-six excellent sketch plans of tidal power projects which Mr. Davey includes in an appendix to his work would be much more intelligible had a north point been added to each map, and a few additional names of places inserted to enable the reader to locate more clearly the exact position of the areas proposed to be impounded. These plans cover such widely different localities as the Severn Estuary, Morecambe Bay, the Firth of Forth, the river Humber, and remote lochs on the West Coast of Scotland.

Modern Mechanical Engineering. Edited by A. H. GIBSON, D.Sc., and A. E. L. CHORLTON. London: The Gresham Publishing Company, Limited. Six volumes. Price 14s. net each.

IF, as the editors of these volumes define it, mechanical engineering is an art having for its object the harnessing of all natural powers for the service of man, it is obvious that to deal with it in a satisfactory, useful and thorough manner would require more than six volumes, each containing under 300 pages printed in uniform large type. Even accepting a less grandiloquent definition of the art than that advanced by Professor Gibson and Mr. Chorlton, it is certain that mechanical engineering, with all its modern

developments and ramifications, is still too vast a subject to be covered in an acceptable way within anything like the limits of this work. The editors have recognised this fact and have exercised considerable restraint in the selection of the aspects of mechanical engineering to be included in their undertaking. The principle of selection upon which they have proceeded is not very clearly stated. They have chosen, they say, to keep the practical requirements of engineers as much as possible to the fore, and to leave aside current speculation as to possible new sources of energy, new prime movers, and so on. This statement gives little idea of the scope of the books, but short of a detailed account of their contents, we can suggest no means whereby we may indicate to our readers what is included in them and what has been omitted from them.

The editors themselves are directly responsible for but three of the thirty-four portions into which the work is divided, Professor Gibson contributing the sections on hydraulics and water turbines, and Mr. Chorlton the section on modern pumping machinery. Mr. G. A. Burls supplies three sections on gas engines, aero-engines and gas producers; Mr. Joseph Horner contributes a like number on patternmaking, foundry work and the machine shop; and Mr. J. J. Guest three on applied mechanics, the elasticity and strength of materials and mechanism. Two sections are supplied by Mr. G. M. S. Sichel, who deals with the fitting and erecting and the transport of heavy machinery; and two by Mr. E. G. Weeks, who deals with pipe work and coal and ash-handling plant. Mr. Harold Davis is also responsible for two sections, his subjects being machine drawing and design and the operation of oil engines. There are three instances of joint authorship, Messrs. W. B. Davidson and F. F. P. Bisacre contributing the section on applied heat; Messrs. R. J. Kaula and W. M. Selvey that on steam turbines; and Messrs. M. Tombs and H. D. Teage that on motor cars. The remaining thirteen sections are each the work of a different author, and are as follows:—Drawing-office organisation (G. W. Thomson); testing and properties of materials (T. H. Burnham); fans and air compressors (J. E. Ellor); hydraulic machinery (Alfred Towler); refrigeration (G. W. Daniels); rivets and riveted joints (A. S. Lindsay); steam boilers (J. M. Dickson); engineering chemistry (W. Carrick Anderson); the reciprocating steam engine (W. H. Owen); condensers and cooling towers (R. Royds); the operation of land power stations (J. W. Jackson); oil engines (James Richardson); and the operation of gas engines (P. R. Allen).

While the range covered is undoubtedly extensive it cannot be said that the work covers all the subjects of prime interest to mechanical engineers. There is, for instance, no section specifically devoted to lubrication, the information given being scattered throughout the volumes incidentally to the treatment of other subjects. Again, except for one or two special references in Mr. Weeks' chapter on pipe work, practically no information is given regarding modern developments in welding. Even though such developments may in a considerable measure be regarded as lying within the province of the electrical engineer, their application is a subject of great importance and interest to his mechanical brother. The kindred subject of oxy-acetylene cutting is, so far as can be discovered, wholly neglected. Then, again, it is a little strange to find that while patternmaking and foundry work are each given a separate chapter, no provision is made for smithing and forging. The very important subject of gauging is most inadequately treated, limit gauging in particular being dismissed in a score of lines in Mr. Horner's section on the machine shop. There is a section on motor cars—which incidentally is much more of a "popular" than a technical nature—but it is confined to the petrol-driven passenger vehicle. The steam-driven commercial wagon is not discussed. Aeronautics is reasonably enough excluded from the purview of the work, but with considerable inconsistency, aero-engines are given a fairly lengthy section all to themselves.

Other omissions and defects might be mentioned, but we have probably said enough to show that the "principle of selection" adopted by the editors has been liberally interpreted. The individual portions, with but few exceptions, are satisfactorily executed, although in nearly every instance they show signs of severe compression. The illustrations are almost uniformly of a high order of merit, and will probably prove the most valuable features of the work. For reference purposes, the volumes will no doubt be found useful, but it cannot be said that they approach to anything like that completeness which will enable readers to dispense with other works.

The Mechanical Properties of Fluids: A Collective Work. London: Blackie and Son, Limited. Price 20s. net.

WHEREAS the mechanical properties of solids are well understood and can be found described and discussed in many excellent treatises, the mechanical properties of liquids and gases are still, to many people, vague or at least unfamiliar, and are dealt with in a diffused manner in a variety of specialised papers or works. In this book, edited, we gather, by Sir George Goodwin, an attempt has been made to bring together within the compass of one volume, accounts of some ten different aspects of fluid mechanics which have recently been studied and advanced by the aid of mathematics or practical research.

In the first chapter Dr. Allan Ferguson defines and discusses the density, compressibility, viscosity and other familiar conceptions employed in the description of the mechanical properties of fluids, and gives the results of some recent researches aiming at the evaluation of these factors. In the second chapter Professor Horace Lamb gives a summary of the mathematical theory of fluid motion, dealing specifically with stream-line, vortex and wave motion in incompressible fluids, and the manner in which such motions are modified by the existence of viscosity. In the third chapter viscosity and lubrication are dealt with by Mr. A. G. M. Michell. While briefly summarising his own well-known mathematical investigations on lubrication, Mr. Michell by no means confines his attention thereto, but presents a satisfactory survey of the results arrived at by others from Reynold's time onwards. In his section on viscosity he covers subjects—such as viscous flow in tubes and the determination of viscosity coefficients—which have no direct or peculiar connection with lubrication.

The fourth, fifth and sixth chapters have been supplied by Professor A. H. Gibson, and are devoted respectively to stream-line and turbulent flow, hydro-dynamical resistance and phenomena due to the elasticity of a fluid. In the earliest of these chapters Professor Gibson includes a brief discussion of the connection between the laws of fluid motion and the transmission of heat between a solid surface and a fluid moving over it. The chapter on hydro-dynamical resistance is principally devoted to the resistance between solid bodies and liquids. It touches only briefly on the aeronautical aspect of the subject, and when it does so makes reference in general to results obtained by the Advisory Committee for aeronautics in the years preceding the war. The third of Professor Gibson's chapters covers the phenomena occurring when a fluid moving in a pipe is suddenly brought to rest—that is, "water hammer"—and when a stationary fluid in a pipe is suddenly set in motion. It also deals with wave transmission of power as developed by Mr. Constantinesco. In the seventh chapter Mr. G. I. Taylor discusses the determination of stresses by means of soap films. This very beautiful method of analysing the complex stresses in certain forms of specimens submitted to certain forms of force was, we recall, evolved as the result of purely mathematical investigations. The method as developed by Mr. Taylor and Mr. A. A. Griffiths at the Royal Aircraft establishment during the war was described in a paper read before the Institution of Mechanical Engineers in the autumn of 1917—see our issue of December 21st of that year. That the contoured surface of a soap film stretched over a hole of any shape in a plate and subjected to a pressure from below should represent with a very close approach to absolute accuracy, the distribution of stress in a metal bar of the same section as the hole when such bar is subjected to torsion, is not only a mathematical curiosity but a fact that can be, and has been, put to practical use. It is not easy, however, to understand why it should be discussed in a book on the mechanics of fluids, for except that it has an interest in the mechanics of soap-bubbles—a subject which has engaged the attention of more than one learned professor—its bearing lies entirely with the mechanics of solids.

In the eighth chapter Dr. A. E. M. Geddes deals with "Wind Structure." In the ninth Dr. C. V. Drysdale discusses "Submarine Signalling and the Transmission of Sound Through Water." In the tenth and last Mr. F. R. W. Hunt treats of "The Reaction of the Air to Artillery Projectiles." These chapters, like Mr. Taylor's, are of very great interest, particularly Dr. Drysdale's, but they cannot be said to carry the scientific understanding of the mechanical properties of fluids beyond the point reached in the earlier and more general chapters. As affording illustrations of the practical application of the principles established by the other writers they are, however, of distinct value as well as interest.

In a collective work of this nature there is a distinct risk that while each chapter is written by an expert on the specific subject dealt with in it, the different authors will write independently of each other, use different symbols, and in places duplicate each other's work. There are no such defects in this volume. All the authors use a common system of symbols which are set out in a list at the beginning, and so far as we have discovered there is no single instance of what might be held to be unnecessary duplication. Indeed, from the cross references from one chapter to another one might almost believe that the work had been written by one person or, at most, two. In places the treatment is highly mathematical, as might be expected, for one cannot very well discuss, for example, the mathematical theory of fluid motion without introducing mathematics of a fairly high order. But elsewhere, if it cannot be described as a practical work, it certainly contains much information of great importance and value to practical workers.

The Hydraulic Principles Governing River and Harbour Construction. By CURTIS MCD. TOWNSEND. New York: Macmillan and Co. 12s. net.

THE author, who is a retired Colonel of Engineers in the United States Army, has, during his professional career, collected a mass of useful information, particularly in reference to the regulation and improvement of rivers in the United States. His chapters on the formation of rivers, the laws governing the flow of water in rivers, sediment in non-tidal rivers, discharge, flood prediction and regulation and on the construction of dykes and other forms of bank protection, are excellent, and obviously embody the accumulated wisdom of many years' practical experience.

The book is in no sense a general text-book or a complete exposition of river engineering. In many respects it is deficient, but some parts of it, particularly the chapters we have indicated, constitute a real contribution to the scanty literature of river hydraulics. In particular, the chapter on river discharge and flood prediction is an excellent *résumé* of the subject, bearing evidence of long association with the flood problems which confront American engineers in charge of river regulation. In an appendix a detailed description is given of the methods of flood prediction practised on the Mississippi. When, however, we come to some of the later chapters, we find that the author restricts himself to brief notes on a few aspects of the subject with which he is dealing. In fact, the chapters on dredging, buoys and lights and harbours, which, altogether, occupy not more than twelve pages, although interesting in themselves, are of little value to the student. The same criticism applies to the last chapter on "The Economies of Water Transportation."

We notice in the short bibliography which forms an appendix to the volume, that the references are, in general, to what might be described as nineteenth century engineering literature. The author does not appear to have kept abreast of the technical literature of his subject during the past decade and more. This is particularly noticeable in reference to European literature. For instance, in Chapter 6, Colonel Townsend devotes several pages to a discussion of Fargue's researches on the form of river beds; but his only reference to the published works of this authority on the subject is a note relative to a paper printed in 1868. Colonel Townsend does not appear to be acquainted with M. Fargue's valuable work of 1908—"La Forme du lit des Rivières a Fond Mobile."

As we have already pointed out the book is by no means a complete exposition of any one of the many subjects with which it deals, nor is it suitable as a text-book for students. Its value lies in the excellent exposition of principles, not founded on theoretical research or mathematical premises, but the outcome of many years of close and intelligent investigation and observation. It is hardly to be expected that Colonel Townsend's views should in all matters coincide with those of other authorities, for there is, perhaps, no branch of engineering on which more diversity of opinion exists among civil engineers than the regulation of large rivers. With the exception of a few diagrams and graphs, the volume is without illustrations and, unfortunately, it lacks an index.

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Moving Pictures: How they are Made and Worked. By Frederick A. Talbot. London: W. Heinemann, Limited, 20-21, Bedford-street, Strand, W.C. 2. Price 10s. 6d. net.

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Industrial Sweden, 1923. Published by the General Swedish Export Association in connection with the Gothenburg Jubilee Exhibition, 1923. A few copies are available at the office of the Swedish Consulate-General in London at Bank Chambers, 329, High Holborn, W.C. 1.

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LONDON UNDERGROUND RAILWAYS, ROLLING STOCK OVERHAULING WORKS AT ACTON

(*For description see opposite page*)

FIG. 1—SMITHS' SHOP

FIG. 2—PART OF MACHINE SHOP

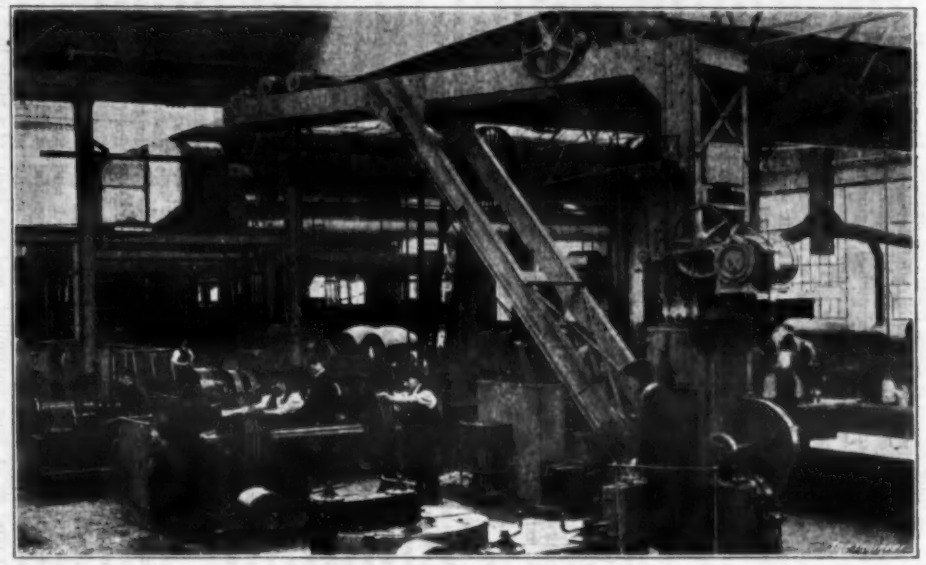


FIG. 3—PART OF WHEEL SHOP

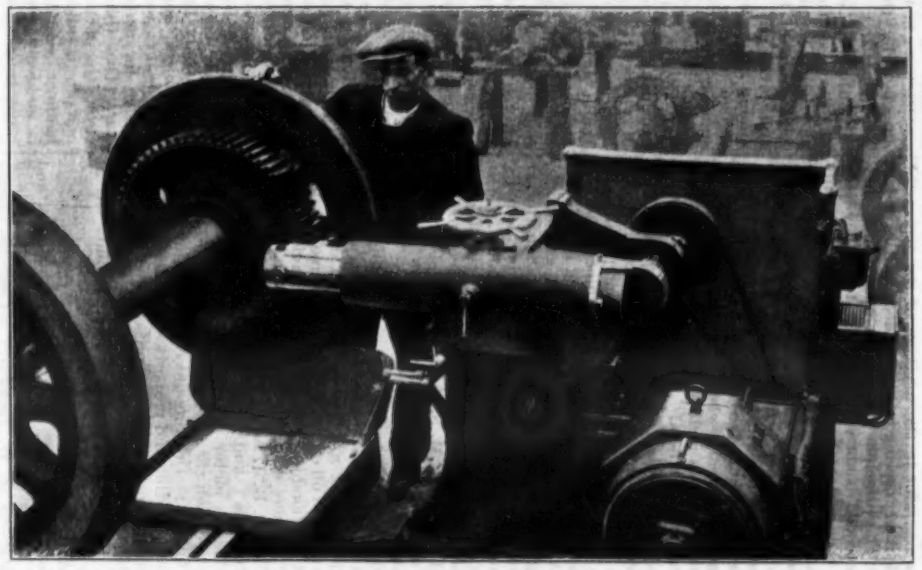


FIG. 4—MACHINE FOR DRILLING TIRES

The Acton Works of the Underground Railways.

IN consequence of the increase in the number of cars and the car mileage on the London Underground Electric Railways, it was decided in 1920 to establish a central repair works. A site, comprising about 30 acres of land, was acquired near the Acton Town Station for the erection of new buildings, which will eventually serve for the overhauling of the rolling stock belonging to the Metropolitan, District, London Electric and City and South London and Central London railways. In the first portion of the new works, which was put into operation in December, 1922, there is sufficient equipment to deal with the periodic overhaul of the District, Bakerloo, Piccadilly and Watford joint stock, but additional land is being acquired, so that eventually the works will be capable of coping with the Central London, Hampstead and City and South London stock, and all car painting and body work and the repair and manufacture of engineers' stores and supplies for the allied railways will also be carried out at this centre. At the present time, the new works give employment to approximately 500 hands. About sixteen cars are overhauled per week, and the stores manufacturing work for the outlying districts is also dealt with. In designing the new works, careful consideration was given to the various systems in vogue, and, finally, it was decided to give the so-called "progressive" system a trial. In motor car works, where that system is in use and where each vehicle moves forward in stages until the overhaul works is complete, travelling platforms are used, but railway coaches are, of course, too large and too heavy to enable such platforms to be adopted. Special bogies, known as "accommodation" bogies, were therefore designed for carrying the bodies after they have been removed from the service bogies, so that they can be moved from place to place by means of electric traversers and capstans.

Work on the first part of the new establishment—which is shown in Fig. 6, page 176—was begun in 1921, and the overhauling operations were started in December, 1922. The main shop, which consists of a building 400ft. long by 250ft. wide, is divided into four main sections, *i.e.*, the truck section, the car body and electrical equipment section, smithy and wheel and axle section, and machine and fitting section. The plan—Fig. 5—shows in heavy full lines the shop in its present condition, whilst the dotted lines show proposed extensions to the sections 1 and 2. An additional extension, comprising a woodworking, body and paint shop, is shown in the full lines, and an armature winding shop is also to be built.

The truck department occupies a main bay, 400ft. long by 50ft. wide, and it is served by two 15-ton electric overhead travelling cranes made by Craven Brothers, of Manchester. From the inwards sidings the cars that are to be overhauled are passed by means of the 45-ton electric traverser shown in Fig. 7 to the dismantling section, where, by means of electric capstans, they are removed from the traverser and are placed in the dismantling pits, which are situated at one end of the truck bay. After the trucks have been disconnected from the car body, and the latter has been lifted by means of two overhead cranes, the bogies are withdrawn towards the truck dismantling section. The body is then lowered on to two accommodation bogies, and it is drawn out again on to the electric traverser by means of the capstan, and is transferred to the car body department. The bogies are then dismantled by means of the overhead cranes, and the various parts are passed through washing tanks, which, however, are to be replaced by a special washing machine with a travelling chain floor. Having been washed, the parts are passed to the particular department or section where the necessary repairs are carried out. All the motors are transferred complete by means of electric battery trucks to the motor overhauling section. After they have been cleaned, the truck frames are conveyed by the overhead cranes to one of thirty-five stances in the frame repairing section, where any necessary repairs to the frames are carried out and the work of reassembling the various parts, such as axle-boxes, brake gear, &c., is also undertaken.

At the other end of the truck bay is the assembly section, which contains six stances for reassembling truck frames on to the axles ready for the motors. There are also two assembly pits for the replacement of the car bodies on the running bogies, and to enable the accommodation bogies to be withdrawn. The overhead cranes are used for lifting, and an electric traverser, which is a duplicate of that at the inwards end of the shop, is used to transfer the car body from the body department to the truck department. After a car has been lowered on to its bogies, the accommodation bogies pass out on to the traverser, and proceed by way of a track outside to storage sidings at the inwards end of the shop, ready for use again on other cars. When a car has been lowered on to its bogies and has been checked to ensure that the height of springs, &c., is correct, it is passed out of the shop across the traverser to the inspection and finishing shop, which is provided with two tracks and two pits. In this shop the current-collecting gear is erected, and the electric and brake connections are made and tested, and after the testing work has been completed the car is again passed on to the electric traverser which conveys it to the outside sidings leading from the works.

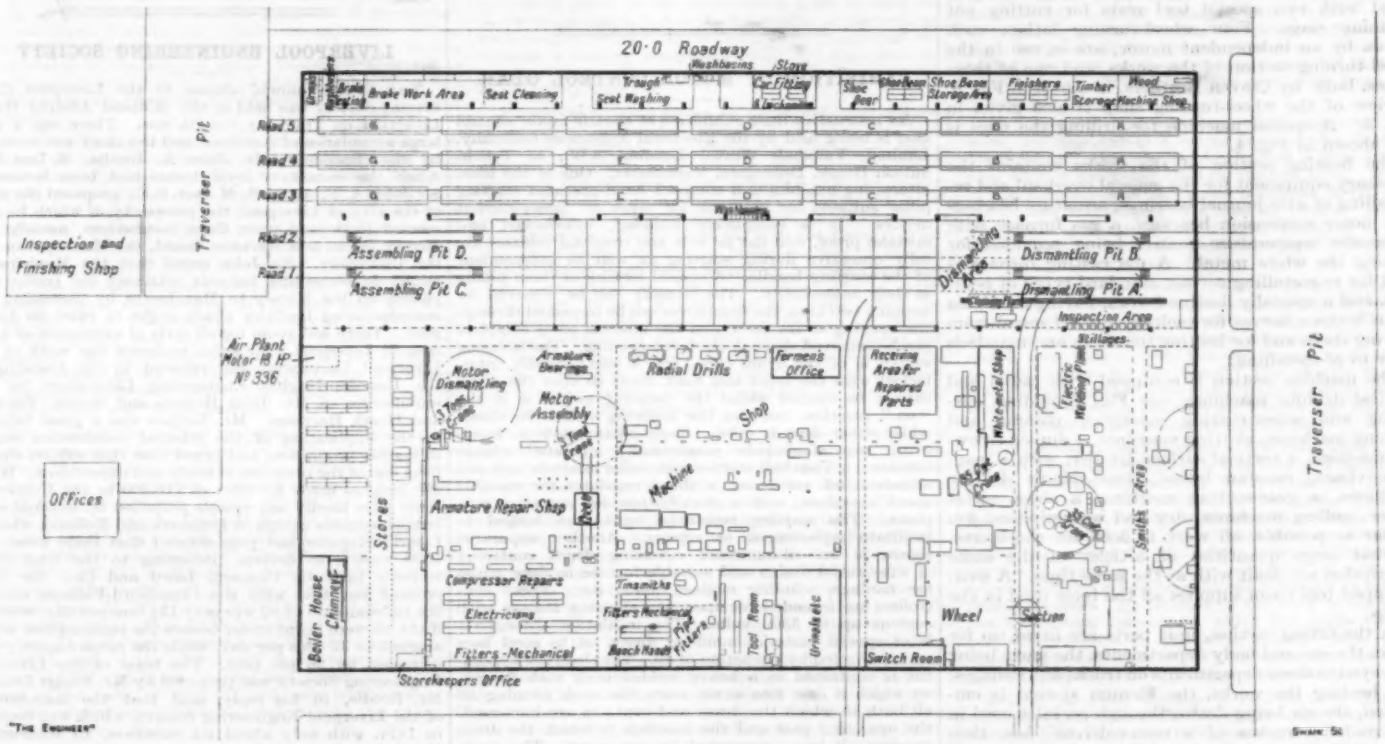


FIG. 5—PLAN OF THE ACTON ROLLING STOCK OVERHAULING WORKS

The car body section occupies a bay 400ft. long and 50ft. wide, is provided with three tracks, each capable of accommodating seven cars, two tracks being set aside for motor coaches and one for trailer coaches. This arrangement allows the trailer cars, which can be overhauled in a relatively short space of time, to pass through the shop at a greater rate than the motor coaches. The vehicles leave the electric traverser at one end of the building and pass through the body section in four stages, and since they are supported on the accommodation bodies, they are carried at a height which facilitates the dismantling and assembly of the electrical equipment and compressors. Any repairs that are necessary to the underframe are carried out in stages in the body section, and the movements are made by means of electric capstans. The time taken for a motor coach to pass through this section is six days, and that for a trailer coach four days. In the case of the motor coach the four stages of the work consist of (*a*) high-tension testing and stripping the control and compressor equipment; (*b*) overhauling electrical fixtures and making good the defects found during the high-tension testing; (*c*) refitting compressor contactors, and final adjustments and tests on the control gear; and (*d*) inspections and insulation tests. The work associated with the trailer cars is also divided into four sections:—(*a*) High-tension testing and inspection of bus lines and connecting boxes; (*b*) overhauling switch panels and making good the defects found during the high-tension testing; (*c*) overhauling heating and lighting circuits; and (*d*) inspection and insulation tests.

The work of overhauling the body structure, fittings, &c., is carried out during the time the car is passing through the various stages, and on arriving at the exit end of this department the car passes on to the electric traverser, which transfers it on to the assembly section of the truck department. The motor section of the works is divided into four areas, known as the dismantling, armature repair, field coil and motor case, and motor assembly areas. The complete motors are brought from the truck department to the motor-dismantling department by means of electric battery trucks, and they are then dismantled under a 3-ton electric jib crane, made by Joseph Booth, Limited. Within the radius of this crane there is a blowing plant for the purpose of blowing out the dust from the armature and motor case, while an exhaust fan, which is driven by a 20 horse-power motor, draws the dust into a tank.

The armatures are then passed into the repair shop, Fig. 9, in which there are special machines for commutator turning, keyway cutting, commutator slotting, armature binding, and so forth. These machines are placed in the same order as that in which the various operations are carried out, and after the armatures have been cleaned they are placed on a truck and passed through a stoving oven. On leaving this oven the armatures are picked up by a 3-ton electric jib crane, made by Joseph Booth, Limited, which serves the motor assembly area, where the armatures are tested before they are assembled in the motor cases. In the meantime, the motor cases and field coils receive attention in the area set aside for that class of work. Two radial drills are placed within the radius of one of the jib cranes, to enable stud holes to be drilled and tapped in the motor cases. The motors are next assembled and conveyed by means of electric trucks to the assembly section of the truck department, which is eventually to be combined with a new armature and field coil winding shop.

The electrical equipment section of the works is provided with fitters' benches, for the overhaul of the electrical equipment, which is brought into this department on trucks and stillages. The parts are dealt with on benches specially allocated for the work, and the parts are transferred to and from the department in complete car sets. The compressor section is equipped with three special stands, which are served by an overhead runway and hoists. The armatures and field coils belonging to the compressors are dealt with in the motor section of the works, and

before the compressors are sent to the body section for mounting on the underframes they are subjected to a thorough test under working conditions.

The brake section is equipped with fitters' benches for the overhaul of cylinders, slack adjusters, brake valves, cocks, &c. There is also a test bench on which the complete equipments are tested under normal conditions, before they are passed on to the body department, where they are mounted on the cars.

The smiths' shop—see Fig. 1—and the wheel and axle section constitute another department. The former is fully equipped for carrying out repairs to brake gear, bogie parts, springs, &c., and an electric welding plant has been provided for building up worn parts. The wheel and axle section is divided into three parts for dealing with tires and axles, wheel turning and repairs to bearings. Two motor-driven hydraulic presses, each having a capacity of 200 tons, and served by a 35-cwt. electric jib crane, made by Gibbon Brothers, are used for pressing wheel centres and gear wheels on to the axles. Five boring mills are used for boring tires to the correct dimensions for shrinking on the wheel centres, and the mills are fed by three compressed air cranes, which were designed and built at the Acton works. When the tires have been bored, they are expanded in two electric induction furnaces, so as to make them fit on the wheel centres, a 35-ton electric jib crane, made by Gibbon Brothers, being used for lifting purposes. Other special plant in this section consists of hydraulic rolls for rolling down the tire-retaining rings, horizontal drilling machines for drilling motor tires after they have been shrunk on to the wheel centre, and an axle journal re-turning and burnishing lathe, provided with two special tool rests for cutting out retaining rings. Four wheel-turning lathes, each driven by an independent motor, are in use in the wheel-turning section of the works, and one of these lathes, built by Craven Brothers, is shown in Fig. 8. A view of the wheel-turning shop is also given in Fig. 3. A special machine for drilling the tires is also shown in Fig. 4.

The bearing section of the works contains the necessary equipment for the general overhaul and re-metalling of axle journal bearings, armature bearings and motor suspension bearings, a gas furnace with automatic temperature control being provided for heating the white metal. A die casting furnace is used for re-metalling certain standard types of bearings, and a specially designed oven, having a moving chain bottom, serves for melting out old metal from bearing shells and for heating the shells and mandrels prior to re-metalling.

The machine section is equipped with radial and vertical drilling machines—see Fig. 2—sliding, surfacing and screw-cutting machines, planing and shaping machines, slotting machines, a duplex screwing machine, a vertical surface grinder, with a magnetic chuck, capstan lathes, three-spindle drilling machines, a gear-cutting machine, a sheet metal cutter, milling machines, dry and wet grinders, &c. As far as possible, all work is done for the stores, so that large quantities of articles of the same description are dealt with at the same time. A well-equipped tool-room supplies all the tools used in the works.

In the fitting section, unit parts are fitted up for use in the car and body departments, the parts being conveyed to these departments on trucks and stillages. For heating the works, the Plenum system is employed, the air being drawn through an inlet cowl in the roof by means of a motor-driven fan, then circulated through a series of live steam pipes, and exhausted through ducts leading to the various parts of the works. The stores are situated inside the works, and a system of loose containers is used for the storage of raw materials and spare parts. Heavy materials, such as steel tires, castings, &c., however, are stored outside the works. Besides an excellent canteen, there are various auxiliary buildings, including administrative offices, oil, petrol and carbide stores, and waste stores, an ambulance room, cycle shed, &c.

WIRE ROPE MAKING IN SOUTH AFRICA.

ONE of the latest local industries to be started in South Africa is the manufacture of wire ropes. This is an important development for South Africa, and for the Rand in particular, and its value and importance are likely to increase, as gold mining is carried on to greater depths and haulages are extended over distances that the old-time miner would have deemed impracticable. Until a couple of years ago, this requirement of the Rand mines was met entirely by the oversea makers, and when Messrs. Haggie, Son and Love determined to free the industry from this dependence upon outside supplies, the enterprise was regarded as a somewhat daring one, because the making of wire ropes, especially of the quality requisite to withstand the exceptional demands of the Rand gold mines, calls for the exercise of considerable skill and costly plant. Both these requisites have, however, been provided, and the firm now enjoys a very big share of the orders placed by the mines.

Hitherto, however, it has been dependent upon Sheffield for the supply of wire with which the ropes are made. Recently steps have been taken to lessen even that partial dependence, with the result that a month or so back the first wire was drawn at Messrs. Haggie, Son and Love's Jupiter Works, and is now being made up into wire rope, which will be the first to be completely manufactured —from the "raw material"—in South Africa, and will be employed in one of the Rand mines.

For the purpose of their factory, Messrs. Haggie, Son and Love were fortunate in securing the property of the old Jupiter Mine, and the various shops, with necessary alterations and additions, have been turned to effective use. It is interesting to note that the whole of the rope-making machinery is of British manufacture. Wire up till recently has been supplied by Arthur Lee and Son, of Sheffield, and that firm, it is interesting to learn, has taken a broad and sympathetic view of its customer's enterprise in enlarging the scope of their works, and its technical director, Mr. J. Bromwell, was at the Jupiter for about six weeks superintending the preparations for this new phase of the industry, and brought with him qualified men to instruct South Africans in the skilled trade of wire drawing.

The Jupiter Rope Works are situated right in the very heart of the greatest gold-mining industry in the world, and they were, even before the latest extension, equipped on the most modern lines. They were established to meet the enormous demand for wire ropes of every description which are used for hoisting, mechanical haulage, &c., in the gold and diamond mines of South Africa. Messrs. Haggie, Son and Love have for some time past been in a position to supply any rope used in South Africa, and although their works have been in operation only about a couple of years, nearly every mine in the country is using their ropes. The fact of these works being in such close touch with the mines is of considerable value to both the manufacturer and the user. In the past, it took from two to three months for the mines to get their requirements from England, and they had, in consequence, to carry enormous stocks of wire ropes. But with the facilities now provided for manufacturing the rope from the first process to the last—a hemp plant having been erected to enable all the hemp cover to be made to the exact sizes required—much valuable time will be saved.

EXHIBITION OF MOTOR CONTROL GEAR.

AN instructive little exhibition of electric motor control gear is being held by the Electrical Apparatus Company, Limited, Vauxhall Works, London, S.W., at Touch-button House, Deansgate, Manchester. One of the most interesting exhibits is a compact hand-operated starting pillar suitable for use with all types of direct-current motors. It is completely ironclad, interlocked and mistake proof, and the no-volt and overload releases are fully operative during starting as well as independent of the starting handle. A special feature of these pillars is their accessibility. The housing can be removed by undoing two nuts, the resistances can be inspected through the opening at the back, and the internal parts complete can be removed through the front opening. The isolating switch is of the drum type, and is mechanically interlocked with the front and back doors so that the doors cannot be opened whilst the isolating switch is in the "on" position, nor can the isolating switch be closed while either door is open. Each pillar contains, moreover, two single-pole magnetically operated circuit breakers, a Vauxhall starter with roller contacts and one minute-rated resistance, a shunt regulator for variable speed machines, and a push-button for stopping purposes. The starting resistance banks are hinged to facilitate replacement or repairs. Another apparatus shown is an oil-immersed reversing drum controller of substantial design and suitable for use in fiery mines for haulage, winding engines, fans, &c. These controllers are intended for operating slip-ring motors with current up to 3300 volts. The insulation throughout is of special material moulded direct on to steel bars and unaffected by the action of oil. The electrical apparatus is contained in a heavy welded tank with flanges, on which a cast iron cover rests, the tank forming an oil bath in which the drum and contacts are immersed, the operating gear and the bearings in which the drum revolves all being supported by the cover. The drum is mounted on an insulated square shaft, which is continued right through the bearing bush and the insulated steel bars which carry the controller fingers, and the terminals are fitted to the bearing brackets. The cover is hinged so that the drum and fingers can be readily lifted out of the oil. The main cover is fitted with two auxiliary covers which serve as ventilators as well as being removable for inspection. The controller fingers are of unusual construction. They consist of brass stampings, which carry the tip, and are hinged on a steel bush bearing in an aluminium-bronze casting. The latter forms the finger base and terminal, and is clamped to the insulated triangular bar on which the fingers are held. There is a flexible connection between the tip and the terminal. Another novel feature of the controller is the construction of the trifurcating boxes, which have swivel attachments so that the incoming and outgoing cables can be led in any direction.

JUNIOR INSTITUTION OF ENGINEERS.

ON Friday, February 8th, Mr. Kenneth Gray, in a lecturette on "Some Physiological Aspects of Heating and Ventilation," which he delivered before the Junior Institution of Engineers, remarked that the usual form of estimates for a heating system of a large building only provided for apparatus sufficient for maintaining a certain internal temperature with a given outside temperature. The attitude of mind towards the heating question was, he said, focussed almost entirely on that one quality—temperature. One of the first conditions that produced the feeling of comfort in a human being was that of healthiness, and that condition was usually to be found out of doors. The greatest degree of comfort was attained when the sun was shining and there was cool moving air; the temperature of the air was comparatively unimportant, but the other qualities which come into account were radiant heat and humidity.

It was not easy, he continued, to reproduce those out-of-doors conditions inside a building, and although at first sight open fires seemed to produce the best imitation, their inefficiency and their intermittent working were serious drawbacks. The walls of a room took a long time to heat up, and when the fire went out the heat they contained was lost. It is noticeable how depressing a room with cold walls could be, and the reason was that although the temperature of the air might be what was accepted as satisfactory, heat was given out from one's body to the cold walls, producing a feeling of chilliness. Walls were often seen streaming with water because the heating apparatus was used only occasionally when the outside temperature seemed to warrant it.

Central heating was economical, but the distribution of heat by heated air fell very far short of the ideal. Radiators heated by water or steam tended to produce an atmosphere which was too dry; but those systems did keep the fabric of the building warm, and with warmed walls it was possible to take advantage of one opportunity of obtaining outside healthy conditions, that was of keeping the windows open. Open windows were generally associated with cold draughts, but it was a fact that with an efficient inside system of radiant heat the windows could be left open with impunity. That was certainly the case when the outside temperature was as moderate as it was in England, although in countries where the temperature fell to zero or below it might not be possible. In American houses, owing to the very dry cold outside, it was found necessary to maintain high internal temperatures which were unpleasant to an Englishman, even when he had been living there for some time.

During the discussion which followed, Mr. Gray said that he thought that the number of north lights now used in factories was not always justified, because the advantage of extra good light was often outweighed by the big expense of a suitable heating apparatus. Some improvement was now obtained by the use of double glazing.

LIVERPOOL ENGINEERING SOCIETY.

THE fiftieth annual dinner of the Liverpool Engineering Society was held at the Midland Adelphi Hotel, Liverpool, on Thursday, the 7th inst. There was a very large attendance of members, and the chair was occupied by the President, Mr. John A. Brodie, M. Inst. C.E. After the customary loyal toasts had been honoured, Sir John A. F. Aspinall, M. Inst. C.E., proposed the toast of the City of Liverpool, the prosperity of which he said seemed to depend upon three institutions, namely, the Mersey Docks and Harbour Board, the Municipality and the University. Sir John urged that the Municipality might do something towards retaining the traffic that passed up the Mersey to Manchester by increasing the manufacturing facilities which ought to exist in Liverpool. There was room for all sorts of extensions of business in Liverpool. Sir John reviewed the work of the Liverpool University, and referred to the founding of the Harrison-Hughes Engineering Laboratory by the munificence of Mr. John Hughes and Messrs. Fenwick and Heath Harrison. Mr. Hughes was a great believer in the application of the internal combustion engine to marine propulsion, and urged that that subject should form one of the branches of study and experiment. When Mr. Hughes made his offer of £10,000 to the University there were hardly any vessels propelled by internal combustion engines except in Denmark and Holland, whereas Lloyd's Register last year showed that there were over 1800 vessels so driven. Referring to the fruit ships recently built by Cammell Laird and Co., Sir John pointed out that with the Camellaird-Fullagar engines the consumption of oil was only 13½ tons per day, whereas if the oil were burnt under boilers the consumption would amount to 32 tons per day, while the cargo capacity was increased by 26 per cent. The toast of the Liverpool Engineering Society was proposed by Mr. Stuart Deacon. Mr. Brodie, in his reply, said that the membership of the Liverpool Engineering Society, which was founded in 1874, with only about six members, all students of Mr. George Fosberry Lister, was now 850, and it ranked as the most important society of its kind out of London. Referring to the suggested new transport road through Lancashire, he said that if Liverpool was as much alive as it ought to be, they would see that the road was made in the interests of the port of Liverpool, while if Manchester was as wise and as open minded as it should be, it would subscribe to that road, so that it might tap the Yorkshire manufacturing districts. Liverpool people were, he said, slack with regard to the Mersey Tunnel scheme, and instanced how London had gone ahead with its scheme for tunnelling under the Thames between Gravesend and Tilbury. The toast "Our Guests" was proposed by Eng.-Captain W. J. Willett Bruce, and replied to by Major-General Sir Lothian Nicholson and Sir Charles Morgan, President of the Institution of Civil Engineers.

AWARD OF THE BESSEMER MEDAL.—The Council of the Iron and Steel Institute has decided to award the Bessemer Gold Medal this year to Professor Albert Sauveur, of Harvard University, in recognition of his eminent services in the advancement of the science of the metallurgy of iron and steel. Professor Sauveur hopes to make the journey to London in order to receive the medal at the hands of Sir William H. Ellis, G.B.E., who succeeds to the presidency at the annual meeting of the Institute on May 8th and 9th.

SMALL CAR TRIALS.—From May 12th to 17th inclusive, the Royal Automobile Club will conduct a 1000-mile trial of small cars. The small car is of interest primarily to the owner to whom the financial aspect of motoring is of importance. This owner is generally his own driver and mechanic. The object of the small car trials, 1924, is, therefore, to provide for the prospective owner of a stock car information on the following points:—What will be the first cost? What will this cost include? What accommodation will be provided, and what comfort? How will the car climb hills? How will it "pick up"? How much looking after and attention will it require? What repairs will be required? What new parts will be required? How much will these parts cost? What outside help will have to be procured to undertake repairs? What will be the fuel consumption, and what its cost? How much oil and grease will be required? The system of marking will take these points into consideration on a predetermined scale.

Railway Matters.

THE former Rhymney and the former Taff Vale lines at Neath have been joined together by new connections. The Great Western and Taff Vale Roath Dock branches have also been connected.

THE only entry of particular interest to railwaymen in the Dissolution List of Honours is a knighthood for Mr. Felix J. C. Pole, the general manager of the Great Western Railway. This, of course, is not a political honour.

THERE was a collision on an electrically-operated railway in Indiana, on the 2nd inst., in which, or in the subsequent fire, twelve lives were lost. Lines similar to this are what are termed inter-urban, and what we should call light railways.

THE Metropolitan Railway is having continued remarkable financial success. From 1906 to 1917 inclusive it paid varying rates of interest, but always under 2 per cent. For 1922 it, however, paid 3½ per cent., and for 1923 it distributed 4 per cent.

A CONTRACT has been let by the Great Western Railway Company for the requisite earthwork to provide for the future doubling of the two remaining sections of single track on the main line between Truro and Penzance, i.e., between Scorrier and Redruth and between St. Erth and Marazion.

THE Middlesex County Council is to make representations to the Prime Minister, the Minister of Transport, and the Minister of Labour, with a view to immediate pressure being brought to bear on the railway companies concerned to secure the extension northwards at an early date of the tube from Finsbury Park.

THE Southern Railway Company recently informed the local authorities that it was the intention to reconstruct the station at Wimbledon. A more uncomfortable station could not, we believe, be found amongst stations of similar importance in the London area. Possibly, the delay in modernising it is due to the prospective changes which will be necessary when the Wimbledon and Sutton Railway is built.

BESIDES the appointment of Mr. James Milne as assistant general manager, mentioned last week, there have been other interesting appointments on the Great Western. Mr. W. A. Stanier has been made principal assistant and Mr. J. Auld the docks and personal assistant to the chief mechanical engineer. Mr. R. Carpmael and Mr. A. S. Quatermaine have been made assistants to the chief engineers.

AT the annual general meeting of the Institution of Railway Signal Engineers on Wednesday last, February 13th, Mr. W. J. Thorrowgood was elected the President for the current year and Mr. A. F. Bound the Vice-president. Mr. Thorrowgood is the signal and telegraph superintendent of the Southern Railway, and Mr. Bound is the signal superintendent of the Great Central section of the London and North-Eastern.

THE value of the railway material exported during last year, as recorded in the Board of Trade returns, was as follows, the corresponding figures for 1922 and 1921 being added in parenthesis:—Locomotives, £2,893,626 (£5,074,843, £7,936,903); rails, £2,560,766 (£2,445,710, £3,097,123); carriages, £987,321 (£2,020,844, £1,549,259); wagons, £3,167,374 (£3,347,310, £6,026,509); wheels and axles, £984,449 (£1,194,397, £1,722,746); tires and axles, £697,676 (£417,077, £1,295,247); chairs and metal sleepers, £950,553 (£2,015,977, £1,522,320); miscellaneous permanent way, £1,305,375 (£1,388,974, £2,654,684); total permanent way, £6,807,256 (£7,655,508, £10,557,529). The weight of the rails exported was 287,534 tons (253,680, 177,101), and of the chairs and metal sleepers, 82,404 tons (143,911, 68,521). During last December locomotives to the value of £192,871 and rails to the value of £55,533 were shipped to India, and rails to the value of £50,788 to South Africa.

A RETURN has been issued by the Ministry of Transport giving particulars of the accounts and statistical returns of the Tramways and Light Railway Undertakings in Great Britain for the year ended December 31st, 1922, for companies, and March 31st, 1923, for local authorities. From it we learn that the total route mileage open for traffic at the end of the year was 2594 miles, of which 1788 miles were worked by local authorities and 806 miles by companies. The total gross receipts for 1922–23 were £31,264,141, as compared with £32,523,339 in 1921–22 and the total working expenditure £23,831,532, compared with £26,835,292, leaving net receipts amounting to £7,432,618 or £1,744,571 in excess of the corresponding figure for the preceding year. The number of passengers carried during the year was 4,349,041,241, an increase of 92,772,549, or 2.18 per cent. as compared with 1921–22. The car miles run amounted to 351,910,233, an increase of 19,830,368, or 5.97 per cent. Of the total car miles run 98.92 per cent. were electric car miles. The return also gives particulars of the working of trackless trolley undertakings in Great Britain.

IT will be remembered that a contributory cause of the Abermule accident of January 21st, 1921, was that the token instruments were fixed in the booking-office; had they been in the signal-box the signalman would have known the exact situation of the trains concerned, and would not have lowered the signals for the local train, and so, despite the errors of others, the subsequent collision would not have occurred. This fact raised the question of the wisdom of fixing token instruments in booking-offices, a practice that has many advantages. Colonel Pringle, however, made no definite recommendation on the subject, except that where the instruments were so fixed there should be interlocking to prevent the starting signal being lowered unless and until a token for the section controlled by the starting signal had been obtained. It is now stated that at thirteen stations on what was the Cambrian system, the Great Western has transferred the tokens to the signal-box. As nothing has, as yet, been done generally in the matter of controlling the starting signals, it would seem as though the Great Western considers the alternative of having the instruments in the signal-boxes the better course.

Notes and Memoranda.

IN an article in the Canadian *Contract Record*, advocating the use of limewash, it is stated that the corrosion or rusting of metal may be prevented by applying a good coat of whitewash. A coat of whitewash will save a lot of trouble if applied to all metal surfaces exposed to the weather. If the implements or tools are allowed to stand out in the open, a wash made of either salt and lime or casein, trisodium phosphate and lime, should be used, but if stored under cover and not disturbed, the simple lime and water mix will answer the purpose.

A MATERIAL intermediate between the diamond and graphite is described under the name of "Glanzkohle" in the *Chemical Trades Journal and Chemical Engineer*. It has a silvery white lustre. Though elastic, it is almost as hard as the diamond, and it is even more resistant to chemicals than graphite. It is prepared by passing the flames of certain gases—such as methane or chloroform—through smooth perforations in a heated chemically inert material, such as porcelain. The new material has an electric conductivity less than that of Ceylon graphite, and it resembles diamond optically more than graphite. Purified by boiling with strong acids and fusing with sodium sulphate, it contained 99.06 per cent. of carbon and 0.48 per cent. of hydrogen.

WRITING in the *Wireless World and Radio*, Mr. W. C. Spikins gives some very sound advice concerning the use of accumulators for operating dull emitter thermionic valves. Many people now using this type of valve, he says, are employing a 2-volt accumulator. As this type of valve functions on slightly over 1 volt and consumes very little current, the battery gets completely exhausted, and is consequently liable to sulphate, necessitating a very long charge to put matters right again. The instructions invariably given on the accumulator make it clear that to discharge below 1.8 volts is harmful to the cell, and until people realise what is really happening when they exhaust a battery completely they will find that dull emitter valves will cost much more in the long run than the ordinary type.

A RECENTLY issued report on a comparison of different shift systems in the glass trade tends to show that there is almost consistently an increase in the hourly rate of output—as well as a decrease in the amount of spoilt work—in the 8-hour shift as compared with the 10-hour shift. The effect on output of shifts of different length has already been investigated by Dr. H. M. Vernon in connection with the tin-plate and steel industries, in which the conditions of work have many features in common with those in glass manufacture. In these investigations comparison was made between shifts of length other than 10 and 8 hours, but the same effect was apparent in nearly every instance, namely, an increase in hourly output on the shorter shift as compared with the longer. Very similar conclusions have been reached by the Committee of the Federated American Engineering Societies, which recently reported on the 12-hour shift in continuous industries.

THE Committee appointed by the late Secretary for Mines to inquire into the question of danger from inrushes of water into mines held its first sitting at the Mines Department on January 31st, under the chairmanship of Mr. Percy Greaves. Mr. Shinwell (the new Secretary for Mines), in thanking the committee for undertaking this important task, said that he realised that the promotion of greater safety in mining was the chief duty of his new post. In the short time that he had held it he had been greatly impressed by the spirit of voluntary co-operation, of which this committee was an example, shown to the Mines Department in this work by all sections of the industry. He referred to the importance and urgency of the particular problem that the committee was to consider, and expressed the hope that they might find it possible to make, at any rate, *interim* recommendations at a fairly early date. It is understood that the next meeting of the committee will be held in Glasgow.

EXPERIMENTAL work on the production of foundry iron from sponge iron in the electric furnace, performed by the Department of the Interior at the Seattle station of the American Bureau of Mines, demonstrated that technically, at least, the process is a success, though large-scale tests are necessary to determine its commercial applicability. Such a process would find application in melting iron in regions remote from blast-furnaces, or where establishment of blast-furnaces would be impracticable. Sponge iron was melted in batch runs and continuous runs, in various types of furnaces. The type of furnace found best fitted for the continuous melting of sponge iron is a deep pit furnace with a single electrode and a conducting hearth. The main problems solved were: High recovery of iron, clean separation of the slag, obtaining metal of a high-carbon content, introduction to the metal of silicon and manganese from the slag to eliminate the necessity of using ferro-alloys, and, finally, the removal of sulphur. In order to produce the best quality of grey iron, an auxiliary furnace would be necessary.

ACCORDING to a recent announcement made by Mr. E. W. Rice, Jr., hon. chairman of the General Electric Company, Schenectady, New York, and quoted in the *Electrical World*, this company has arranged for the assistance of pure electro-physical research in Germany for one year under a committee consisting of Professors Planck and Haber, Drs. Nernst, Laue and Franke. The money is to be employed for the purchase of apparatus and material, and must not be used to relieve the Government of its duty of properly maintaining a laboratory. It is also to be used for the remuneration of co-workers and assistants. It is not to be used for the solution of problems of direct industrial use, such as specified technical processes. The company has also arranged to place a small fund at the disposal of Dr. Nernst, who is director of the Technisches Reichsanstelt in Berlin, for a study of the electrical phenomena preceding and accompanying the breakdown of insulators. This is a problem on which Dr. Steinmetz was at work, but even had he lived, competition would have been useful in the achievement of the results sought for. It is stated that the result of the work of these German scientists is to be made public for the general good of all.

Miscellanea.

THE airship station at Howden, in East Yorkshire, is to be demolished.

THE bar at the entrance to San Francisco Bay is being dredged to a depth of 40ft. for a distance of 2000ft. The present depth is 33ft.

IT is reported that a sum of about a million sterling is to be expended on opening up a new colliery at Lingan, South Cape Breton, Nova Scotia. It is expected that the output of the pit will be 2000 tons a day.

IN order to solve the problem of the congestion on the Island of Montreal and to open new means of reaching the mainland from the island, at least on the south shore, it is reported that American capitalists are studying the possibility of constructing a tunnel under the St. Lawrence.

THE new cable connecting Emden and London direct was formally put into service on the 11th inst. The chairman of the Eastern Telegraph Company, Sir John Denison Pender, sent the first message to Dr. Solmssen, chairman of the Deutsch Atlantische Telegraphengellschaft. The cable runs from Dumpton Gap, near Margate, to Emden.

THE Canadian Geological Survey reports new discoveries of high grade silver ore in the Beaver River district of the Yukon territory. The report says that ore has been discovered bearing 1100 oz. of silver to the ton, and that there is an excellent chance of further discoveries from time to time. The district lies 16 miles east of the discoveries of 1919, and a stampede into the new area is progressing.

THE total trade of New Zealand for last year amounted to £89,453,663, the largest aggregate with the exception of the boom year, 1920. The value of exports was £45,967,119, and of imports, £43,486,544. Exports increased by £3,240,870 over the previous year, and imports increased £8,481,104 over last year. Great Britain took 82 per cent. of the exports and supplied 51 per cent of the imports, of which 73 per cent. were from British countries.

TWO accidents to penstocks, which happened in one week, are reported in a recent issue of the *Engineering News-Record*. One was the bursting of a 30in. lapwelded pipe while it was being filled for the first time. It is part of the Eldorado scheme on the American River in California, and was subject to a head of 1800ft. The other penstock was also a lapwelded pipe, belonging to the Big Creek plant in Southern California, and it burst when one of the units was shut down.

THE new iron ore shipping plant which is to be installed at Melilla will comprise five tunnels under the ore dump containing belt conveyors 40in. wide by 850ft. long. The ore will be fed into these conveyors from above, and, in turn, they will feed two shuttle conveyors arranged at right angles to the tunnel. The shuttle conveyors will supply another conveyor running along the pier, which will work in conjunction with a travelling ship-loading tower to deliver the ore into the ship.

THE annual general meeting of the Institution of Heating and Ventilating Engineers was held on February 11th at the Holborn Restaurant, W.C., when Mr. P. M. B. Grenville was made President for the year. In his presidential address, he suggested that the younger members should be included in the Council and on committees. Other suggestions for the future were the formation of provincial branches, and the institution of a bureau of information by a few experienced members to stimulate greater interest. He referred to the work of the Institution's Research Committee, which had made very considerable progress in providing reliable data, and he appealed for further generosity to ensure that the investigations should continue without intermission.

THE Lyons Fair, which is to be held from March 3rd to 16th, will be on a somewhat larger scale than last year. There will be eight new halls, making a total of twenty, accommodating 1700 stands. In addition, there will be stands in cement and wood along the Quai de la Tete d'Or, while agricultural machinery, for which a large space is necessary, will be accommodated in the Cours de Verdun, near the Lyons–Perrache railway station. As an introduction to the Fair itself, an International Congress for the expansion of foreign relations will be held at Lyons from March 1st to 4th. The programme of the Congress will include the study of questions connected with the circulation of capital, the commercial *régime* applicable to colonies, trade with countries where the rates of exchange are high, &c. Great Britain, Switzerland, Holland, Italy, Czecho-Slovakia, and Austria will be represented. The number of exhibitors at the Fair will be unusually large. We understand that 2500, including exhibitors from nine foreign countries, have already sent in their applications for space. Metallurgy, machinery, electrical and heating apparatus will be particularly well represented. The space devoted to motor cars will amount to 5500 square metres.

WE learn from Lloyd's Register of Shipping Returns of vessels totally lost, condemned, &c., between July 1st and September 30th, 1923, which have just reached us, that during the period under review 86 vessels, with a combined gross tonnage of 119,627, were for various reasons—whether by loss at sea, by burning, by being broken up, or what not—struck off the register. Of the total, 65 were either steamers or motor ships, and 21 were sailing vessels. Great Britain and Ireland head the list, both in numbers and tonnage. They lost 19 self-propelled ships of a total gross tonnage of 24,115, though only one small sailing boat of 117 tons was lost, which brought the total tonnage lost up to 24,232. It is of interest to note that the figures represent only 0.23 of 1 per cent. of vessels owned and only 0.13 of 1 per cent. of tonnage owned. The United States of America come next in order, with a total loss in tonnage of 20,995, comprised in four self-propelled and four sailing vessels, and Japan came third with a loss of 12,089 tons—only seven vessels going to make up that total. Norway came fourth, with 11,260 tons, comprised in four vessels, and Germany fifth, with 10,543, also comprised in four vessels. Holland had the distinction of not losing a single vessel.

LONDON UNDERGROUND RAILWAYS, ROLLING STOCK OVERHAULING WORKS AT ACTON

(For description see page 173.)

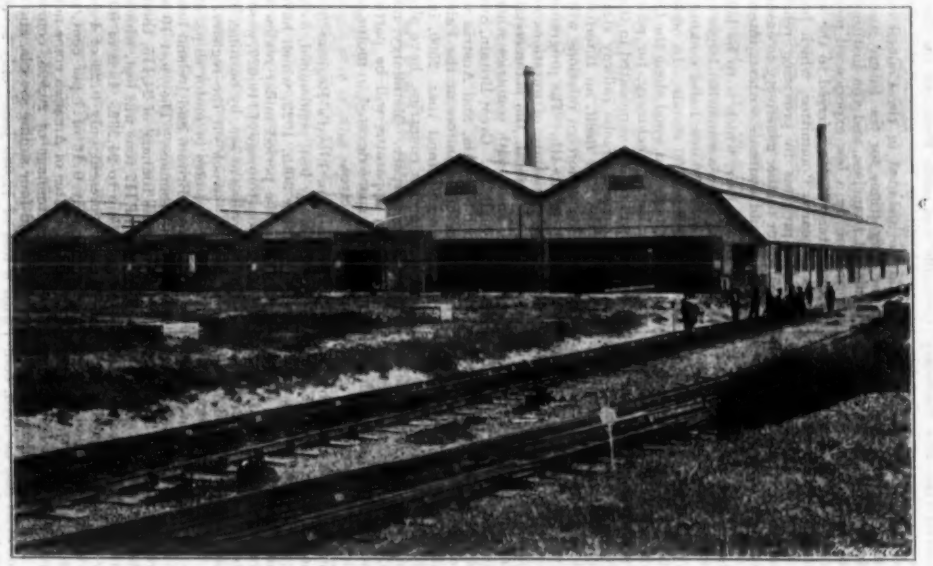


FIG. 6—EXTERIOR VIEW OF WORKS

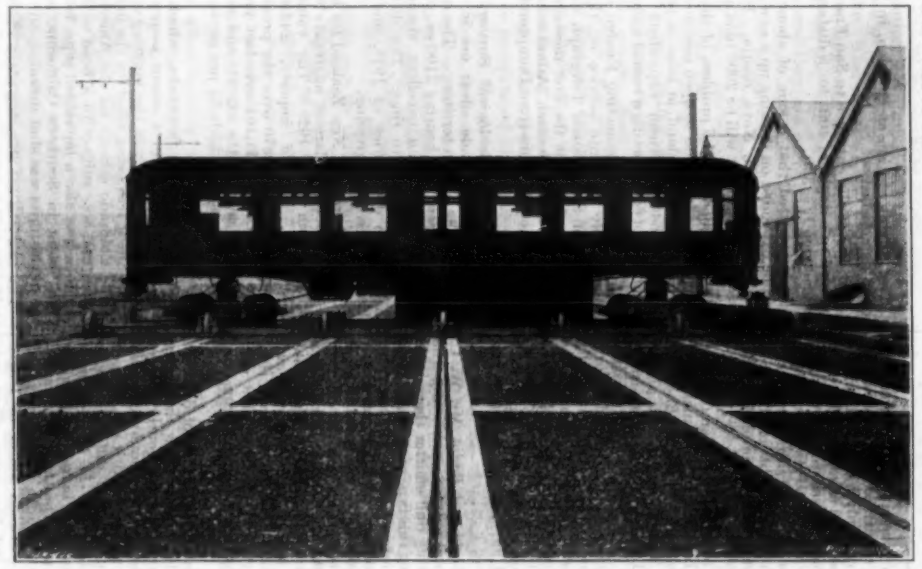


FIG. 7—45-TON ELECTRIC TRAVERSER

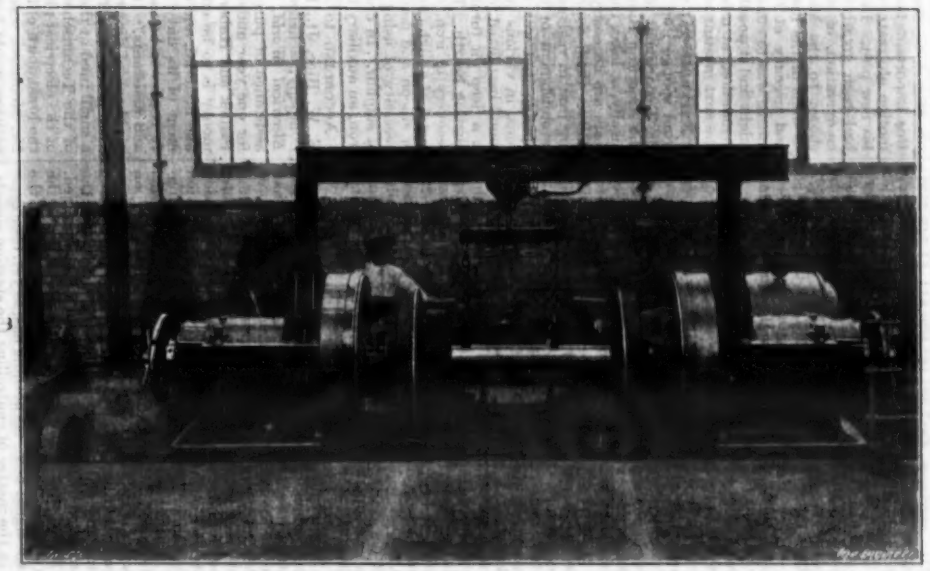


FIG. 8—WHEEL TURNING LATHE

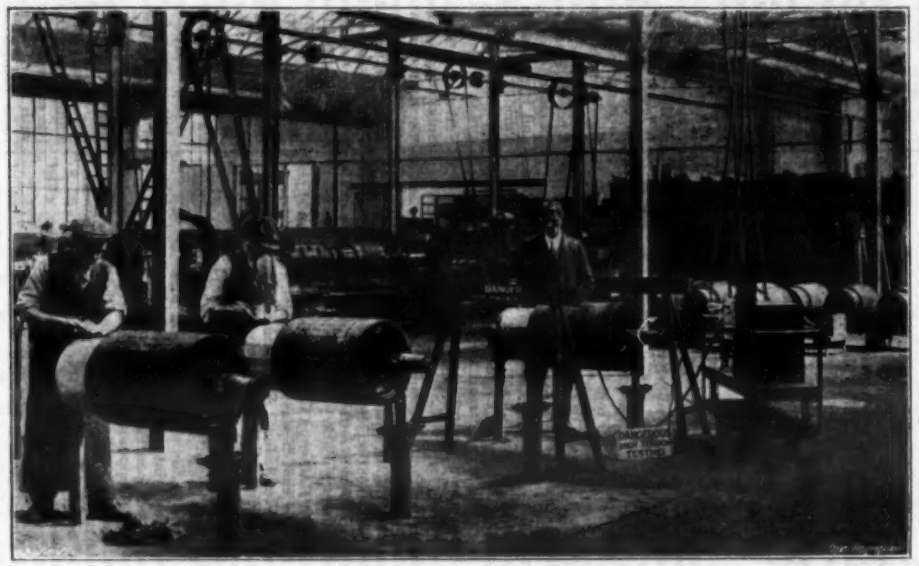


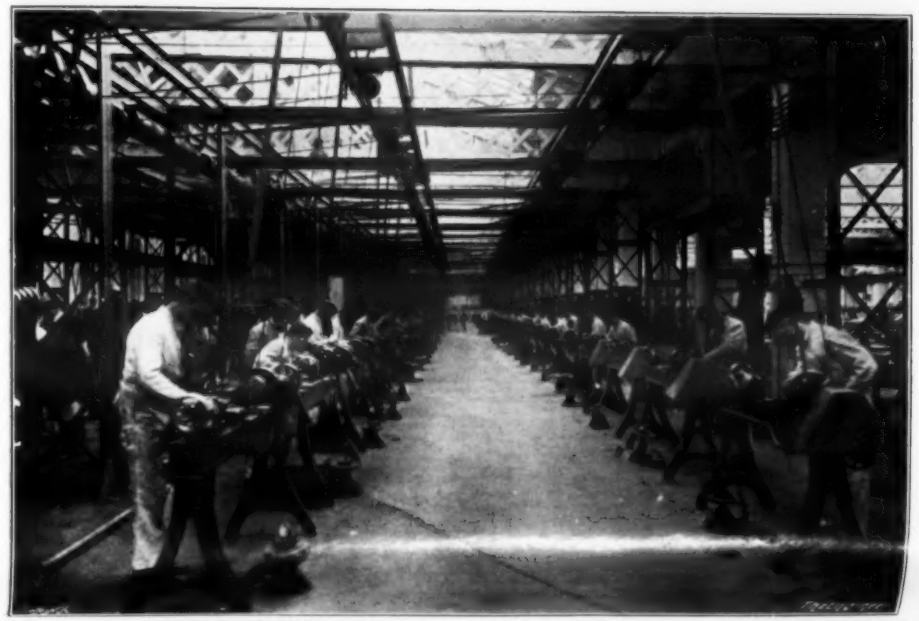
FIG. 9—ARMATURE REPAIR SHOP

HALTON CAMP TRAINING CENTRE FOR AIRCRAFT APPRENTICES

CARPENTERS' SHOP

COACH AND BODY BUILDERS' SHOP

SHEET METAL WORKERS' SHOP



SHEET METAL WORKING SHOP

BLACKSMITHS' SHOP

RIGGERS—AERO SHOP

FABRIC SHOP

ACETYLENE WELDERS' SHOP

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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of THE ENGINEER.

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DEATH.

On the 10th February, at "Kinfauns," Queen's-road, Portland, ARTHUR EDWARD MARRIAN, Assoc. M. Inst. C.E., A.M.I. Mech. E., third son of the late Henry Marrian, of West Hampstead, London, in his 50th year.

THE ENGINEER.

FEBRUARY 15, 1924.

German Locomotives for India.

AN announcement was made in the Press on Saturday last that an order for five tank engines for the Indian State Railways had been placed with a German firm. Whilst it caused a good deal of comment and criticism from the general public, it can hardly have come as a surprise to any of the locomotive builders in this country. They knew well that public tenders had been asked for, that the Indian Stores Department is obliged to accept the lowest tender for equal quality, that Germany was certain to tender, and that her tender would be lower than theirs. They knew, moreover, that political questions would have little or no effect, and that the Stores Department would hesitate no more in placing orders in Germany on this occasion than on previous occasions, or than it had done in sending contracts to America. But if British locomotive builders were not surprised that the order had been placed in Germany, their chagrin at losing it is none the less bitter. The order, it is true, is not a big one, probably £20,000 or so; but, nevertheless, there are locomotive firms in this country which would have been very glad of it; firms which have seen their shops less than half full for many months past, and which cut their quotations to the last farthing in the hopes of securing the work.

In considering this matter, it is as well to be quite candid on certain points which there have been attempts to obscure. There is no doubt at all that the Hanover firm which has secured the contract can build the engines, and build them well; it has the necessary experience; it will be bound by precisely the same specifications; and will be subject to the same inspection as any British firm; and it will work to the same general drawings. It is probable, indeed, that the German engineers are more compliant than American builders, and more in sympathy with a standard of finish and workmanship which is higher in Europe than elsewhere. We have, then, not a particle of doubt that the builders will supply all parts to a rigid specification without demur, and that they will submit gladly to the closest inspection. They have built a good many engines already for India, and are quite conversant with the terms under which the work must be carried out. Let us therefore clear our minds of any oblique reflections upon their ability to conform to the contract, and let us admit honestly, as between engineers, that the work will be well done. From the constructional point, then, nothing can be said against the placing of the order. What, then remains? The political and economic aspect. The wisdom of a State so closely bound up in the British Empire, a State which probably owes its present integrity to the arms of the Empire, helping the late enemy of the Empire so soon after the conclusion of Peace and at a time when the head and parent of the Empire is known to be struggling with unemployment, may surely be called in question. We care not what the standing regulations may be; there are occasions on which a State is justified in breaking or overriding any regulations, and we hold this to be one of them. It is said that the difference between the German tender and the lowest British tender was only twenty per cent.—a matter of not more than five or six thousand pounds. May we not ask if it was wise, for that small sum, to deprive Great Britain of work that it needed and to take a step which may be misconstrued by the natives of India? Had the Stores Department of the Indian State Railways been ruled by high policy rather than by the letter of its regulations, the order would not have gone to Germany. We must observe, moreover, that this step must lead inevitably to others of a more serious kind. The Indian State Railways purchase annually something like two million pounds worth of railway stores of all kinds. Hitherto, nearly all the work has come to Great Britain, but in the near future, if the rule that the lowest tender for equal quality is adhered to, and with the present example before us, more and more of the work will go to Germany, which for reasons it is unnecessary to develop is now, and will remain for long, able to undersell British builders. We are forced therefore to contemplate the unhappy possibility that British builders of locomotives may have to face impossible competition unless some favouring action upon the part of Empire purchasers is taken. It is not our business to say what might have been done in this case, but we cannot believe that it would have passed the wit of politicians to find a hole in the regulations through which they could, had they so desired, escaped from the necessity of placing an order in Germany.

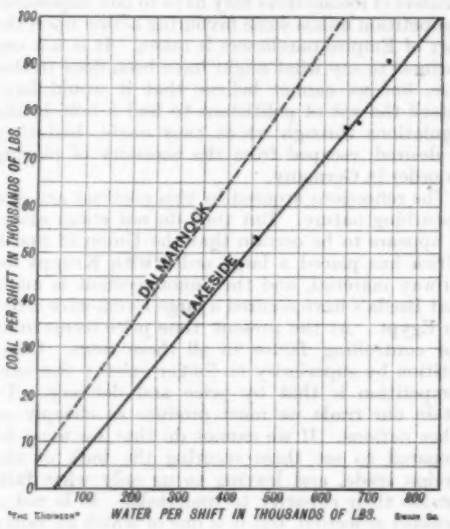
The reflections aroused by this contract are of a disturbing nature. But they do not stand alone. It appears to be certain that the Union of South Africa has placed a large order with Krupps for railway material, and the announcement is made that Breda's have secured a large locomotive order for Egypt. At the present time price seems to be the controlling factor in all these cases. Competition by superiority no longer exists; the only competition is that by price and delivery. To retain our trade we must produce as cheaply as other nations. If we cannot do that we must be prepared to see them securing the bulk of the foreign trade, and leaving to us only what falls outside their capacity to undertake. It is not a pleasant reflection, but it is one of which all ranks of society must ponder. Many of our factories could be run more economically, many of them demand the expenditure of more capital for renovation and extension; we must arrest the tendency to strike on the least provocation; we must induce our workers from the highest to the lowest to labour harder for the money they receive. All classes are disposed—no doubt as a relaxation after the strain of war—to demand an easier life. They cannot have it. It is work we need and work comes only to those who work hardest.

The Parsons' Line.

WE presume that many of our readers have followed with interest the discussion between Mr. Napier and Mr. Swindin, which has taken place during the past few weeks in our correspondence columns. It arose out of Mr. Brownlie's paper, read before the Institution of Electrical Engineers, on Powdered Fuel. In that paper the author gave a table of tests of a boiler at the Lakeside Station of the Milwaukee Electric Railway and Light Company. These tests appear to show that the boiler and economiser absorbed 84.6 per cent. of the heat supplied by the fuel, or, in Mr. Brownlie's words, "the net results are 85–86 per cent. actual working efficiency month in and month out on the comparatively low-grade Illinois coal of about 11,500 B.Th.U.'s per pound (high calorific value)." "These figures," Mr. Brownlie continues, "are based in the first place on a most elaborate series of special tests carried out under actual running conditions, probably unsurpassed in the world for care and accuracy, and for the time and trouble taken. Secondly, they are the results of continual weekly records taken as part

of the routine of the station control." It is necessary to bear these words in mind, and to observe especially that the figures are those obtained in ordinary station routine. Mr. Napier took the necessary figures and laid them down in diagrammatic form, obtaining thereby a Parsons' line which, if correct, must indicate that with the consumption of no coal at all the Lakeside boilers would still generate a considerable volume of steam! Mr. Swindin challenged the accuracy of Mr. Napier's result, but fell, we believe, into an error which brought him to a wrong conclusion. We have ourselves examined Mr. Napier's curve, and it appears to us to be substantially correct, but before discussing it and the absurd result to which it inevitably leads, it is perhaps desirable to say a few words about the Parsons' line with which some of our readers are probably unfamiliar.

The Parsons' line was "invented" by Mr. R. H. Parsons when, a few years ago, he was engineer to a Canadian power station. It shows the coal burnt or the water fed to the boilers on the basis of kilowatt-hours generated. There is, of course, a marked variation in these items, as the total output increases or diminishes. When the load is large the consumption of coal and water is low; when the load is small more water and coal are consumed per kilowatt-hour. If there is no useful load at all, but the boilers are standing by, there is still some consumption of coal and water, and even when the station is working at full power the "no-load" loss remains a constant factor in the total coal consumption. Now, if we take squared paper and set up kilowatt-hours as abscissæ and as ordinates employ all the figures we can obtain for coal consumption at different outputs, we shall find that the dots



collect themselves in a narrow area through which a mean line is easily drawn. We may do exactly the same thing for water consumption, and in both cases we invariably get a straight sloping line which cuts the zero ordinate at some considerable distance above the zero point. It shows, in other words, that, as we have already noted, even when no useful current is being generated, a certain amount of coal has still to be burnt. These charts are always made out in thousands of pounds of coal and thousands of kilowatt-hours, per shift of eight hours. The Parsons' line represents average coal consumption of the station at all outputs, and by marking down upon the diagram at the end of each shift the quantity of coal burnt for the number of kilowatt-hours generated, it is at once seen whether the economy of that particular shift was below or above the average. The line has proved so invaluable in enabling the station engineers to see at a glance what the coal consumption per unit for each shift has been, and it has had such a marked effect in improving the efficiency of stations, that it is now very widely used, and its accuracy and validity has never been questioned. Indeed, the whole thing is so simple and so obvious that there is no scope for question. The only point—assuming that the measuring instruments are accurate—about which there can be any particle of doubt is the position of the mean line amongst the dots. That is a weakness common to nearly all graphs, but in this case experience shows that ordinarily the dots fall so close together that anything like a material error is impossible. It is particularly to be observed that the line is always straight, and no one has ever suggested that it should be curved. Still working on the same principles, a third Parsons' line can be obtained by using for the ordinates and abscissæ water evaporated and coal consumed. In this case, of course, as in the other two, the line is a straight one, inclined, and cutting the zero ordinate at a point above the zero which indicates the amount of coal burnt to meet radiation and other losses. It is around this third line that discussion has centred, and for the convenience of our readers we reproduce here Mr. Napier's diagram. The figures on which the Lakeside line is based are taken from Mr. Brownlie's Table No. 8. Mr. Brownlie, himself, as we have already shown, holds them to be "unsurpassed for accuracy," and we are confident that the American investigators will uphold his opinion. The hourly figures for five separate tests, at five different rates of output, are given. Mr. Napier took these figures and multiplied each by eight—for an eight-hour shift—and set them down as seen on his diagram. We have checked the diagram, and there is no doubt about its accuracy. There can, also, be little or no hesitation in accepting the Parsons' line as drawn by Mr. Napier through the points. Indeed, if anything, noting the position of the last dot, the line might have been drawn even steeper than it is. In any case, it leads to the absurd conclusion that with no coal burnt between 40,000 lb. and 50,000 lb. of water would be evaporated per shift of eight hours. Mr. Swindin has endeavoured to escape from this conclusion, but not, to our mind, with success. With regard to his first diagram—see our issue of January 18th—we need say nothing; the wrong figures were obviously employed for it. Mr. Swindin did not attempt to defend it when Mr. Napier had pointed out his slip to him, but replotted the data quite correctly and in accordance with Mr. Napier's diagram. But he did not draw the best line through the observations. Instead, he proposed another line which passed below the last of the five points and above the four others. By thus altering the inclination he removed the anomaly. We cannot be asked to accept a procedure which defies good practice, and until further explanation is forthcoming, must regard Mr. Napier's version of the Parsons' line as the right one.

From this brief examination it will be seen that it is now, as they would say themselves, "up to" the American engineers to show why the Parsons' line leads, in this case, to an absurd conclusion. Their best defence would be that there are not sufficient observations to establish the true slope of the line, but if they employ it they must impeach the "unsurpassed" accuracy of the tests. Rather than make such an admission they may contend that the Parsons' line is not necessarily straight; but that position would have to be held against a large mass of experience. If neither of these defences of the observations can be upheld, the only course would be to admit that there was some constant error in metering either the coal or the water. We hesitate to believe, even in the face of the diagram which leads to that conclusion, that an error in calibration could have crept in. We suggest, however, that the matter cannot be left where it is. Mr. Napier has raised what appears to be a very important point, and the Parsons' line or the American figures must remain under suspicion until it has been cleared up.

Boiler Efficiency.

By W. S. PATTERSON, M.Sc., A.I.C.

THE term boiler efficiency usually refers to the percentage of the heat of the coal passing from a boiler in the form of steam less the amount of heat admitted through the feed water. This percentage combines both the efficiency of heat transmission and also of combustion.

A knowledge of the weight of fuel burned with its calorific value, and the weight of water evaporated with the temperature of the boiler-feed, and the pressure and temperature of the resultant steam, gives the information necessary to carry out the calculation. A normally good boiler has an efficiency of 70 per cent., but the exact meaning of this figure is a debatable point. Much diversity of opinion still exists as to whether the "gross" or "net" calorific value of a fuel has to be employed when calculating the boiler efficiency, and if the "net" value is used, there is little agreement again as to how it ought to be deduced. The general procedure is to determine the "gross" calorific value of the dry fuel in a calorimeter, and then from the percentage of the moisture present in the coal "as fired" and the hydrogen content to calculate the "net" value. This means calculating the amount of water formed by the combustion of the hydrogen and adding it to the moisture in the coal as fired, and then calculating the heat required to evaporate this total amount of water to steam. The figure obtained is then deducted from the gross calorific value, since no boiler can effect the recovery of the latent heat of this steam, and the resultant value is the practical "net" figure.

No definite rule appears to exist regarding either the temperature to which the steam leaving the boiler furnace is presumed to be heated or to what temperature the products of combustion in the calorimeter are cooled, both of which factors make an appreciable difference to the "net" result. Further, the allowance for hydrogen is frequently completely overlooked in making the calculation.

The determination of the hydrogen necessitates skilled chemical manipulation, but empirical methods are available for calculating the hydrogen content from the volatile matter in the coal, and may be used with a considerable degree of accuracy; but where a standard trial is being conducted, the hydrogen of the coal should be determined by combustion in the laboratory.

The determination of the moisture in the coal can be readily performed, and should be carried out as soon as possible after the sample has been taken.

The usual deductions for these two quantities of heat are by no means negligible. Thus, in a sample of coal of 12,500 B.Th.U. on a dry basis, which contained 8 per cent. of moisture and 5 per cent. of hydrogen, these allowances involved a reduction of the "gross" calorific value of some 12 per cent., and this lower heating value is that which should obviously be employed for all practical purposes.

There is considerable need for a standard method of calculating the calorific value of fuel, since no definite comparison as to boiler performance and practice is possible without such standardisation* and a Committee of the Engineering Institutions, with one or two members from the Institute of Chemistry, might do good service in this direction.*

It is only necessary to read through a paper like that recently presented before the Institution of Electrical Engineers by Mr. Brownlie, to realise the existing confusion and the difficulty of realising exactly the meaning of "stated efficiency."

COMMERCIAL EFFICIENCY.

If allowances were made for the heat losses referred to an ideal set of conditions might be taken as representing 100 per cent. efficiency.

Assume that the ideal flue gas shall contain 15 per cent. CO_2 and pass away from the boiler at 450 deg. Fah., and the ash discharge contain less than 5 per cent. combustible matter. The "commercial efficiency" of the boiler can be obtained by a simple calculation from the percentage of CO_2 and the temperature of the flue gas. Continuous readings of both can be taken by automatic recorders. A lower percentage of CO_2 means excess air drawn in, and an increased flue gas temperature represents heat lost. The sum of these losses gives a figure which in many cases might be considerably reduced by careful working. The more practical efficiency would appear to be that which is based not on the total heat possible under conditions never obtained in practice, but on the amount of heat which can be extracted by a boiler working under the best conditions. It should be of more practical value and encouragement to the works superintendent to know that his boiler efficiency is within a certain percentage of an attainable practicable figure than to have it as a percentage of a purely hypothetical and unobtainable conversion of the heat of the fuel into steam.

* Probably the Joint Committee on Boiler and Engine Testing Codes which is now sitting has this matter in hand.—ED. THE E.

Obituary.

JAMES SUMMERS.

THE death is announced of Mr. James Summers at the advanced age of eighty-one years. Mr. Summers, who was a well-known engineer of the North-East Coast, was a native of Sunderland. He served his apprenticeship with Messrs. G. Clarke and Co., marine engineers of Sunderland, and, afterwards, was superintendent engineer to Messrs. Marwood, shipowners, of Whitby. For thirty years he was consulting engineer to Messrs. E. Harris and Messrs. J. Watson and Co., of Middlesbrough. Among the various works he superintended on Teesside was the building of Harris's deep-water wharf on the south bank of the river to provide a suitable berth for a line of big German boats.

While in the service of Messrs. Harris, Mr. Summers went with a party from Liverpool to Archangel to salvage a ship which had been wrecked by the ice. On the way out their own steamer struck on a rock and went to pieces off the coast of a small island, called Kem, in the Arctic regions. The survivors took a small boat, but as there were too many in it for safety, each of them had to take his turn in being dragged by a rope through the icy-cold water till they got to shore on the island, which was of a rocky and desolate character. The men, with their clothes frozen, had nothing to eat for five days, until they were found by some Lapland fishermen,

and months afterwards managed to find their way to Archangel.

During the last few years Mr. Summers had acted as consulting engineer to Messrs. Hanson, Brown and Co., Middlesbrough, and up to a year ago he daily journeyed from his home at South Otterington, near Northallerton, to business at the Teesside town.

Pulverised Coal: Its Preparation and Utilisation.*

By R. JACKSON.

PERHAPS it is not remarkable that the progress of pulverised fuel has been much more rapid in other countries than in our own. In France, the use of pulverised coal has made great progress, owing in some measure to the large percentage of fines produced, and the limited coal supplies available. The progress made in the United States is phenomenal, and it has been estimated that the annual consumption of pulverised coal exceeds 30 million tons, of which some 2½ million tons are used for steam raising, and it is anticipated that the figure will rise to 3½ million tons in a few months time. The class of coal used is invariably good quality run-of-mine, whereas in France low volatile and waste fuels are commonly used. American coals are usually softer than English coals, and this characteristic has undoubtedly assisted development.

The South American countries, particularly Brazil, have made great progress in the use of pulverised coal. The friable nature and low value of Brazilian coal practically preclude its economical use in the raw state. It is now being used in powdered form, not only for stationary furnaces, but also for locomotives. India's best coal seams are being rapidly exhausted, and public opinion is being focussed on to pulverised coal as a means of efficiently using India's second grade coals.

In this country we have been fortunate in having abundant supplies of good hard coals, but the enormous coal consumption is rapidly depleting the better seams, and has led to the working of other coalfields whose product is not so uniformly good and where the proportion of waste is much higher.

Pulverisers.—The most common type of pulveriser in use in this country is the tube mill, sometimes operated in conjunction with a ball mill, the latter acting as a preliminary and the former as a final pulveriser. The coal under such circumstances would enter the ball mill in the centre falling amongst the balls while the mill is rotating.

The tube mill usually consists of a riveted steel cylinder supported on hollow trunnions, and rotated at constant speed by gearing. The interior of the mill is lined with cast iron plates, and the grinding medium consists of chilled cast iron balls, pebbles, or other materials. The coal is fed through one trunnion, and the finished product delivered through the other. A mill of 2 tons capacity per hour would probably be 5ft. diameter by 22ft. long, and would contain 6 tons of balls or pebbles when running at 28 revolutions per minute. It will be observed that the output of such pulverisers in relation to the total weight, power required and space occupied, appears disproportionate; yet, notwithstanding, the tube mill enjoys a measure of popularity, probably because of its general immunity from breakdowns. It is, however, an inefficient apparatus, and much experimental work has been done to improve its performance.

Pendulum Mills.—The Griffin mill was introduced about thirty years ago, and consists, briefly, of a roll head which carries a long pendulum arm, on the lower end of which is mounted a roll which makes contact with a steel die ring. When the roll head is rotated the pendulum arm also rotates, but the end carrying the roll is free to move outwards. The coal is crushed by the pressure exerted between the roll and the die, owing to centrifugal force, and it is stated that the 30in. Griffin mill exerts a pressure of 6000 lb. and the 40in. Grant 15,000 lb.

The Bradley mill differs from the Griffin mainly in that it has 3 rolls, the pendulums being supported from a yoke mounted on a central shaft, the fine material passing through screens at the outside of the die.

The Simon-Carves and Raymond pulverisers are both of suspended pendulum type, the former having 3 rolls and the latter 4 or 5 rolls. They differ from the previous mills of this type by being totally enclosed, the ground product being drawn away by a fan. It is usual to make the upper part of the casing into a grading or elutriation chamber, where the air velocities fall so low, as to allow the coarse particles to precipitate into the grinding zone, whilst the fine particles remaining in suspension are delivered to the storage hoppers.

The principle of the Roulette and Fuller mill is similar, though details of construction are different and pulverising is done by the pressure exerted by balls running in a race. The balls are rotated by a pusher mounted on a vertical shaft. The coal being fed by suitable means between the balls, is quickly reduced to granular and pulverised state.

The Sturtevant and Bonnot mills differ in principle. In the former type the ring or die is rotated, and pulverising is performed by the elastic pressure of rolls. This pressure can be varied to suit the class of pulverising under consideration.

The Bonnot mill has a stationary ring, the rollers being rotated by a spider and pulverising done by the effect of centrifugal force. This latter mill is fitted with a chamber for air separation. Both are horizontal mills and do not necessitate the use of vertical shaft motors, bevel gears, or twisted belts.

Storage Bins, Feeders and Burners.—From the pulverising mills the ground material is delivered carried in suspension on air, or by worm conveyors or elevators, to the powdered coal bin.

If delivered in suspension on air it is necessary to precipitate this dust, a most difficult matter, which is often accomplished by batteries of cyclone separators connected in series, the main vent passing back to the mill, whilst a small vent is left open to atmosphere. The precipitated material is discharged into the storage bins ready for use.

The usual arrangement in the cement industry is that of a large storage hopper, holding 40 tons or more of powdered coal, at the base of which the worm conveyors —according to the number of kilns—are inserted, and which can be driven at variable speed. These worm conveyors transport the coal from the bin to the delivery pipe of the fan, where the air picks up the dust, and projects it into the kiln for burning.

Anyone who has studied the stratification of gas mixtures, must be perfectly aware that such arrangement cannot provide that intimate mixture of coal and air which Crampton found so necessary in 1871 for good combustion. Nevertheless, it has proved quite suitable for cement work, probably because combustion spaces are not restricted, and rapidity of combustion or a short flame is not desired.

The application of powdered coal to the firing of boilers rendered it necessary to obtain complete combustion in the minimum period of time, so that combustion chamber proportions could be kept within reasonable limits, and has led to the design of innumerable types of feeders, mixers, and burners, all with the avowed object of projecting an intimately mixed and combustible dust cloud into the furnace at low velocity and in the desired proportions.

When the boilers or furnaces are numerous or scattered, it is necessary to have some means of transporting the coal from the pulverising plant to the bins. The common method is undoubtedly the screw conveyor, but the air-pressure system is finding great favour. The two systems most popular are the Fuller-Kinyon system and the Quigley. The former consists of a worm pump rotated in a long cylinder by an electric motor. The coal falls from the bin into the worm and, after being discharged at the end of the worm in a slightly compressed state, meets a small jet of compressed air which aerates and renders it so fluid that it can be propelled easily through long distances.

The pressure used is up to 45 lb. per square inch for distances of 1200ft., and a 6in. diameter pump will propel about 4 tons per hour this distance. Smaller pressures may be used for lesser distances.

The Quigley method consists of two or more bins of, say, 8 tons capacity mounted on scales, one of which may be filling while the other is emptying. From these bins the coal passes to blowing tanks, from which it is driven as pistons of coal alternating with pistons of compressed air. An operator is thus able to deliver a definite quantity of coal to any desired bin by merely opening a valve. It is stated that 2800 lb. of coal can be propelled 600ft. through a 4in. pipe in one minute with air at a pressure of 15 lb. per square inch.

An alternative to these systems of bulk conveyance to bins is that of direct distribution of the coal when suspended in air, to the various furnaces, such as the Holbeck. The system may have a circulating ring main or non-return main, according to conditions prevailing. In the former case the unused coal dust returns to the storage bins for redistribution. The direct system is best applied when furnaces are adjacent, as the cost of distribution is high when scattered, or when the use is very intermittent.

There are several types of unit machines made in this country, perhaps one of the oldest being the Bettington pulveriser, which was developed in conjunction with the well-known Bettington boiler. This machine pulverises by impact or beating, and consists of mild steel shell, forming a fan casing in which the pulverising liners or saw-toothed bars are arranged concentrically with the rotor. The whole is supported on heavy cast iron side frames or pedestals which also carry the bearing brackets for the rotor shaft and feeding mechanism. When in operation the fan forces the coal to the liner, where it comes in contact with the revolving beaters, the finer particles being carried away in suspension on the air stream, to a separator or elutriation chamber, where the coarse particles are precipitated and return again to the pulverising zone.

Another type of unit machine is the turbo pulveriser, which consists of a cylindrically shaped housing divided into three or more compartments forming pulverising chambers, which are fitted with renewable liners, access from one compartment to the next being provided by an aperture of suitable dimensions.

The pulverising medium consists of a number of rotors equal to the number of compartments, which carry a number of beaters on the periphery, the whole being mounted on a common shaft. A fan, which is also mounted on the shaft, is situated at the opposite end to the feeding gear in a special compartment, and its purpose is to induce a draught of air through the pulveriser, which carries in suspension the finer particles from one compartment to another.

The Vickers Griffin mill differs from the two pulverisers previously described, and is a slow-speed machine running from 200–250 revolutions per minute. This may be called a two-stage machine, the coal being fed from an automatic feeder into the first stage, where it is broken down or granulated by beater arms secured to the shaft. From this stage it is drawn into the second or final pulveriser, which consists of a grinding ring with balls. The latter rotate with the shaft, and thus reduce the coal to powder by centrifugal pressure between ball and ring. The fine product is drawn away by a fan into a separating chamber, from whence the coarse particles gravitate back to the ball mill for further reduction, the fine particles remaining in suspension being delivered to the furnace for burning. The degree of fineness of the product may also be regulated by controlling the amount of air passing through the machine.

One of the most recent developments in unit pulverisers is the Atritor—see THE ENGINEER, August 5th, 1921—so called because it pulverises by attrition—*i.e.*, to rub down. The coal, which may have a size up to ¾in. cube, is fed into the hopper and is delivered by a short worm conveyor, running at variable speed, through a discharge port whence it descends to the metal separator. Here the coal is intercepted by a current of cold air—drawn into the machine by the fan—which is travelling at a velocity just sufficient to lift the coal into the pulverising zone. A supply of hot air at a temperature about 450 deg. Fah. is drawn under the base of the machine into the pulverising zone, and its purpose is to dry the coal during pulverisation.

Pulverising is performed by attrition and not by impact or beating, and the pulveriser consists of a rotating steel disc having pegs or impellers mounted on either face.

The function of these impellers is to set up air vortices or turbulence, and the coal particles, according to their mass, become entrained in the air currents which are travelling at sufficiently high velocity to suspend them. The attrition caused by the heavily charged coal air streams travelling at widely varying velocities rapidly breaks down the coal. The fan stream, slowly passing through the mill, carries the finest particles to a rejector, which eliminates all of coarse degree and accepts only those of required fineness, which pass to the fan and are delivered to the furnace for burning.

The stationary pegs act as interrupters, and while pulverisation can be effected without them, they increase the output and efficiency of the mill by assisting the attrition phenomena.

Drying takes place during pulverisation, and is possible owing to the small amount of coal in the mill at any instant—2 lb. or 3 lb.—and the tremendous surface exposed to the drying influence of the hot air when pulverised.

The unit system compares favourably with the storage system for efficiency and labour, renewal and operating costs. The maintenance or running costs, such as for lubrication and sundries, are overwhelmingly in its favour, and the capital and depreciation figures only become comparable when storage plants are of large capacity. It is admitted that the largest unit machine made at the present time could not be applied singly to boilers exceeding 40,000 lb. to 50,000 lb. evaporation, but larger machines are contemplated. When the requirements are extremely large the storage system will at the present time show some advantages, but for installations of moderate size the unit pulveriser is most suitable.

When burning bituminous coal under boilers, the desirable degree of fineness will depend somewhat on the percentages of volatiles or ash in the coal. From the author's experience, when burning coals containing 32 per cent. volatile and 25 per cent. ash, the best combustion conditions are attained when 94–95 per cent. passes through the 100^2 B.S. screen and 80 to 85 per cent. through the 180^2 B.S. screen. On the other hand, when burning high-grade coals combustion has been quite good with fineness of 80 per cent. through 100^2 B.S. screen and 60 per cent. through the 180^2 B.S. screen.

The usual method in America is to use good run-of-mine coal containing 10–15 per cent. ash, and the degree of pulverisation is 90 per cent. through the 100^2 screen. As a general rule, it may be stated that coals high in ash or low in volatile matter should be pulverised finer than low ash or high volatile bituminous coals.

A more important point than the production of superfine dust is that of eliminating the coarse particles having a size of .008in. cube or over, which are often termed "nibs" in the cement industry. The burning of such coarse coal is very undesirable and causes an accumulation of burning or partly burned ash on the walls and floor of the chamber and slagging on the boiler tubes.

It is usually most difficult when considering the conversion of existing boilers fired by hand or stokers to obtain the combustion chamber proportions desirable.

The importance and advantage of high boiler settings and large combustion chambers has not been sufficiently appreciated until recently, with the result that when firing by pulverised coal it is necessary either to raise the boiler or excavate to a suitable depth.

Both these proposals have their limitations, owing to the height of existing boiler-house buildings and the nature of the subsoil, with the result that the combustion chamber design must ofttimes be modified to meet the peculiar conditions. When the ash is highly refractory—fusing at 1450 deg. Cent.—it will usually be precipitated in the combustion chamber in the dry state and will present no difficulties to removal.

If the plant be working intermittently, say, on ordinary day load, and the fusion point of the ash be 1300 deg. Cent. to 1350 deg. Cent., the ash can be easily handled. Slagging occurs chiefly when boilers are operated at high ratings continuously, and when the fusion temperature of the ash is between 1200 deg. Cent. and 1350 deg. Cent. It is accentuated also by shallow or restricted combustion chambers. Under these conditions it is usual in this country to provide means for its removal as slag, and if it is allowed to drip it soon hardens or globulises, and is easily withdrawn. If the chamber can be made of suitable depth a cold zone can be arranged, so that the falling ash becomes chilled and dry before reaching the base of the chamber from whence it can be raked out in powdered or nodulised form.

The method now adopted in America is the water screen, which consists of a series of water tubes in the lower part of the combustion chamber, such tubes being connected with the boiler proper, and the heat generated assists the boiler performance. The function of this screen is to cool the ash and prevent slagging, and it is claimed that a wide range of fuels can be dealt with at high efficiency. A certain amount of fine ash passes through the boiler, some of which is deposited in the flues and passages, and about 20 per cent. is carried up the stack.

The fine ash may be withdrawn from the base of the passages or from pockets in the flues by a suction plant or air ejector. The use of air is more desirable than steam for this purpose. The percentage of fine ash ejected from the stack is barely perceptible against the sky, and though the author's company has several acres of glass roofs, adjacent to a low stack, no precipitation has been noticed. This point compares most favourably with other methods of firing, and it must be emphasised that this discharged material is not soot or cinders, but incombustible superfine material, which is carried in suspension for considerable distances and causes no local nuisance. It is generally assumed that it stays in suspension until precipitated by moisture.

* Abridgment of a paper read before the Coventry Engineering Society on February 7th, 1924.

A Cold-starting Oil Engine.

On the occasion of a recent visit to the Lincoln works of Ruston and Hornsby, Limited, we inspected one of the new type of vertical oil engines, which that firm is making, running under load on the test bed.

These engines, two sizes of which are illustrated by the line drawing Fig. 3 herewith and the engraving on the next page, are of the four cycle, mechanical injection, high-compression type, and are specially noteworthy on account of the fact that they can be started, when quite cold, without the use of a blow lamp or any other heating device.

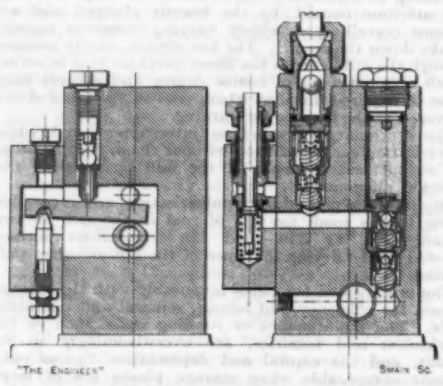
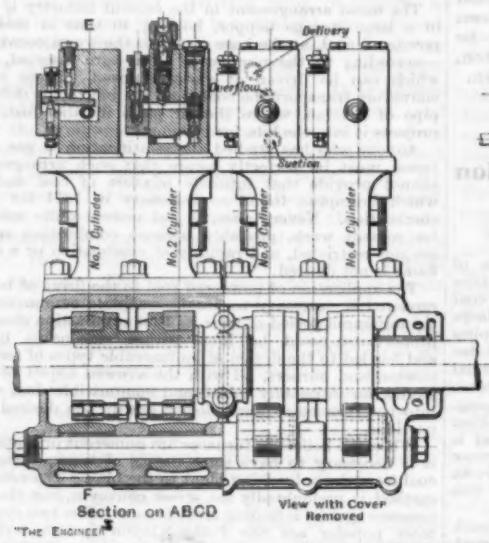


FIG. 1—OIL FUEL BY-PASS BALL VALVE

The compression pressure is sufficiently high to raise the temperature of the contents of the cylinder up to the ignition point, but it is impossible to get any pre-ignition, as the delivery of the fuel charge into the cylinder head is very exactly controlled by the cam-operated pump, and the position of the cams in relation to the crank pins is rigidly fixed once the preliminary adjustments have been made.

Although these engines are spoken of as belonging to the high compression type, they must not be confused with the Diesel engine, in which a much higher maximum pressure is attained and high-pressure air is used to inject the fuel. As a result of the comparatively low pressure—from 700 lb. to 800 lb. per square inch—adopted in the engine under review, the weight for a given horse-power is less, and the scantlings in general are lighter.

Two distinct types of vertical engine are being made at the Lincoln works. One type, represented in our illustrations, which was the one we saw on the test bed, has open frames, while the other is totally enclosed. The open type has, however, light sheet metal covers to close in the openings between the legs of the standards, and as the speed of the engine is only about 250 revolutions per minute, no offence is caused by oil splashing out.



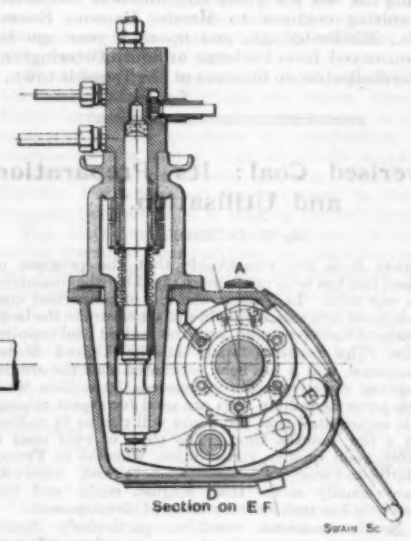


FIG. 2—OIL FUEL INJECTION PUMP

The general design of the larger parts of these engines needs little comment, as it follows recognised principles for heavy oil engines. The cylinders have renewable liners, pressed lightly into place and held by a flange at the top, so that they are easily withdrawn; and the cylinder head, which is a separate casting, is water-jacketed all round. The bed-plate is unusually substantial and has cross bearers to carry the crank shaft bearings between each pair of cylinders. The crank shafts, one of which for a 550 horse-power set, we illustrate in Fig. 4, alongside the shaft of a small petrol-paraffin engine, are machined out of a solid forging, the gap between the webs being hacked out in a slotting machine. The flats shown on the crank pins are used for distributing to the bearings oil, which is supplied through holes drilled up the webs.

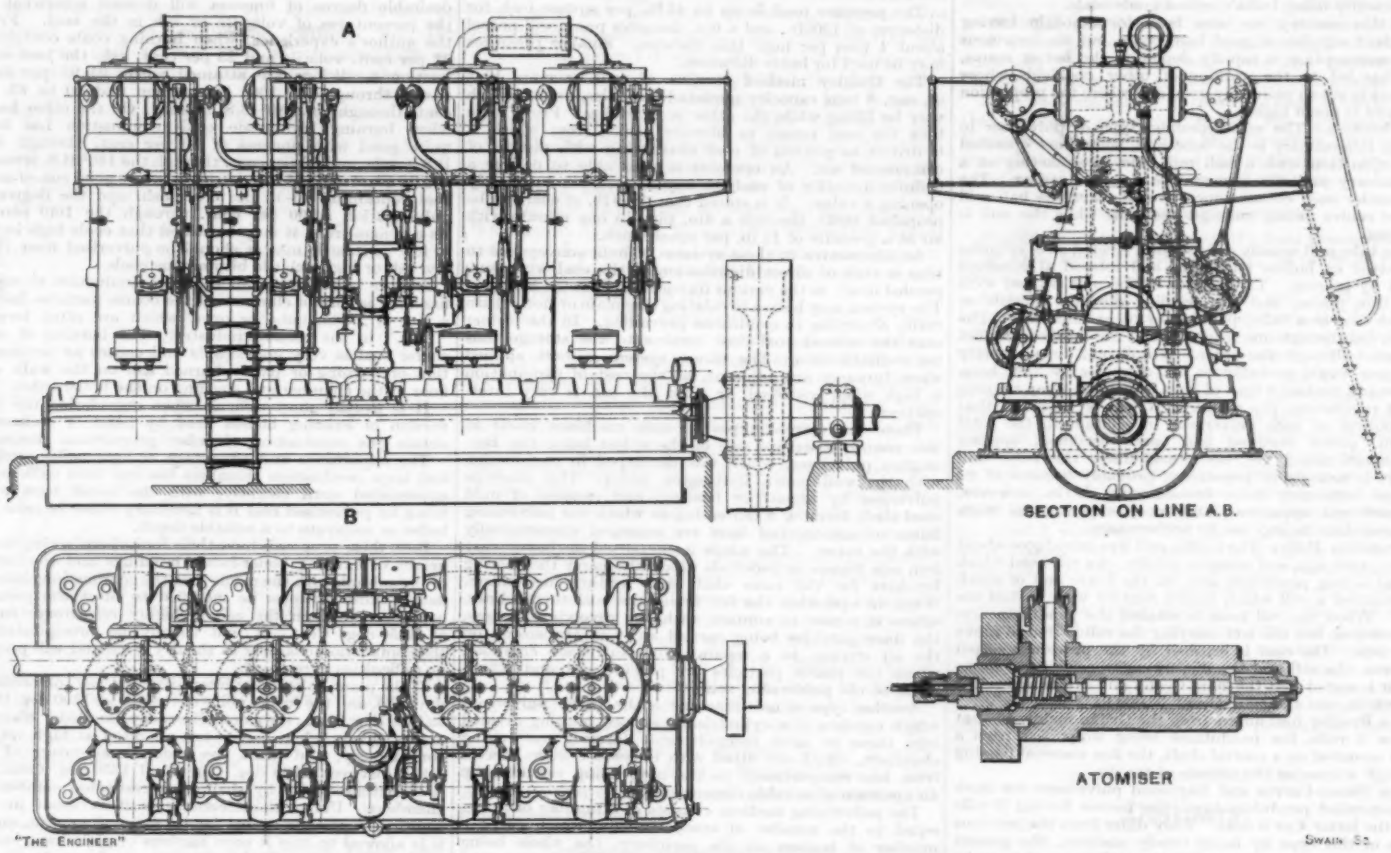


FIG. 3—ARRANGEMENT OF RUSTON-HORNSBY COLD-STARTING OIL ENGINE, AND SECTION OF ATOMISER

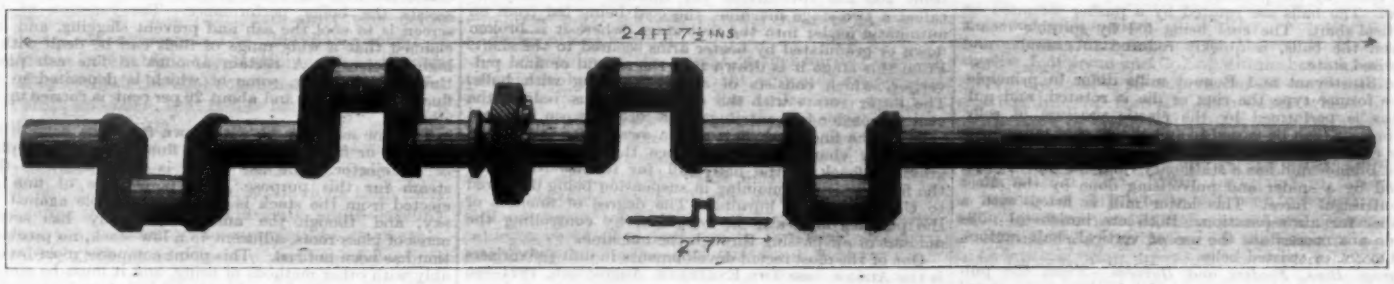
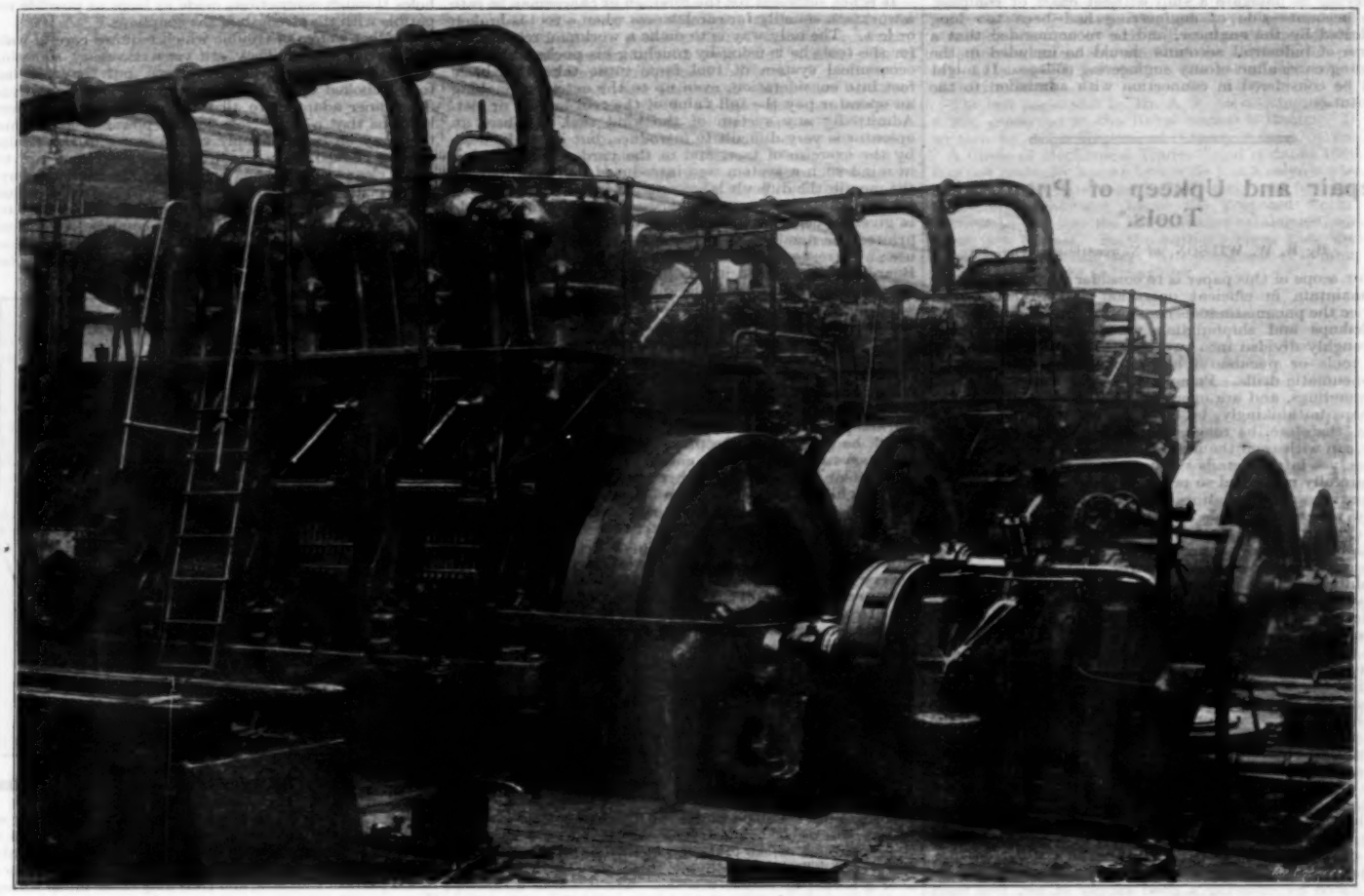


FIG. 4—CRANK SHAFT OF 550 H.P. COLD-STARTING OIL ENGINE

COLD-STARTING OIL ENGINES

RUSTON AND HORNSBY, LIMITED, LINCOLN, ENGINEERS



In the case of four-cylinder engines the shaft is made in two pieces, bolted together at the centre, with the skew gear for driving the lay shaft and governor arranged between the coupling flanges.

The inlet and exhaust valves are arranged horizontally on opposite sides of the cylinder heads, and although some engineers seem to have an objection to horizontal valves, the makers informed us that they have never experienced any more difficulties with them than they have with vertical valves. The valves are operated by separate excentrics on the lay shaft, through rods and bell cranks. On the shaft of the bell crank, which is journalled in the valve head, there is a curved lever that bears against the head of the valve stem and forces the valve open against a spring. The curvature of this lever is such that the valve is let down quite gently on to its seating, but is, nevertheless, opened rapidly. The result is very quiet running, and we were very favourably impressed, on the occasion of our visit to Lincoln, with the comfort with which conversation could be carried on on the platform round the cylinders. The valves are all of the mushroom type, and the gear, with the exception of the excentrics, is enclosed in oil-tight casings. The excentric rods for the air inlet valves, which are at the back of the engine, as shown in the half-tone engraving, would be unduly long if made in one piece and might vibrate when running at full speed. They are, consequently, made in two lengths, and each half is pivoted to a small rocking arm, which can be seen just above the level of the platform. The rocking arm does no work and merely acts as a steady. It will be noticed that there is a small auxiliary bell crank and link work on each of the exhaust valve heads, which are in the front of the engine. This gear is only used for releasing the compression pressure when it is desired to bar the engine round.

The fuel pumps, one for each cylinder, are all grouped together at one end of the engine, and are driven directly off the lay shaft. The general arrangement of the oil pumps is illustrated by Fig. 2, from which it will be seen that the plungers are operated by cams through rocking levers. There is no backlash in the driving gear, which is naturally conducive to silent running, and the injection is timed, on the test bed, by shaping a separate piece screwed into the highest part of the cam. There is thus no chance of the timing becoming deranged during service, but it can be altered, if necessary, to accommodate a change in the fuel oil, for instance, by replacing the sheped piece in the cam.

The quantity of fuel sucked by each pump remains constant at all loads on the engine, but the amount delivered to the cylinders is varied by by-passing so much as is not required to meet the demand on the engine. The by-pass ball valve can be seen on the left of the left-hand view in the enlarged drawing, Fig. 2, and is opened when the little floating lever below is raised by the governor turning the cam under its right-hand end. Some of the oil then overflows back to the fuel tank. The extent of the opening can be adjusted for each pump by means of the set screw abutment of the lever. The pump cylinders are machined out of solid steel forgings, and are very nice pieces of workmanship. Both the inlet and delivery valves are of the ball type, having two balls in tandem.

The fuel atomiser, on which the working of this class of engine so largely depends, is also illustrated in Fig. 3, and again gives evidence of very careful design and workmanship. The spray is produced by forcing the oil through a conical valve held down on to its seating by a stiff spring. When the oil pressure under the shoulder of the valve spindle is sufficient to overcome the spring the valve lifts slightly and the oil, issuing at a very high velocity, is broken up into a fine spray. At our request the makers took out one of the atomisers and fitted it up so that we could see the spraying action at work. Holding a piece of card in way of the jet a foot or so away, we found that the spray was remarkably evenly distributed, very fine, and with no large globules. It should be pointed out that the fuel is supplied by the pipe connection in the side of the atomiser, while the small connection at the end is merely a drain to carry away any oil which may creep up past the labyrinth packing of the valve spindle.

The main bearings are ring lubricated, and the gearing, governor, &c., run in oil baths, while the cylinders are lubricated on the forced feed principle.

These engines are made with cylinders of three different sizes, and with from one to four cylinders per unit, so that sets of from 55 up to 550 brake horse-power can be arranged. The largest set runs at 220 revolutions per minute, and the single-cylinder engine at 300 revolutions per minute. The smaller sets are of the enclosed type referred to at the beginning of this article.

The following table gives the fuel consumption of three sizes of engine, which the makers guarantee with oil of not less than 18,000 B.Th.U. per pound :—

Engine.	B.H.P. working load.	Bore.	Str'ke.	Revs. per min.	Fuel consumption, pounds per B.H.P. hour.
		in.	in.		
4 V.M.	500	18½	25	220	0.42 full load. 0.44 three-quarter load 0.5 half load.
4 V.K.	400	16½	22	250	0.42 full load. 0.44 three-quarter load 0.5 half load.
4 V.E.	200	12	17	300	0.43 full load. 0.54 three-quarter load 0.5 half load.

One of the 4 V.K. engines, of 440 brake horse-power, has been installed at Maidenhead, where the load factor is 44.3 per cent. and the consumption per unit generated for a total output of 304,850 units is, the makers tell us, 0.74 lb. The engine runs on an average 17¾ hours per day, seven days per week, and each evening is called upon to carry 80 to 90 per cent. of the full load for several hours. The guaranteed fuel consumption for this engine was 0.8 lb. per kilowatt-hour at half load. It will be seen, therefore, that the actual results are well within the stipulated amount.

The engine which we saw on the test bed was coupled up with a hydraulic dynometer, and was running on full load. The load was abruptly thrown on and off several times, and on each occasion the engine responded to the change without hesitation. There was only a very slight momentary variation in the speed, and the engine settled down to the normal speed again within a few seconds. It is also noteworthy that the driver had no adjustments to make when the load was thrown off and the engine left to run light. The governor, in fact, had complete control of the set. The exhaust, also, indicated how flexible the engine is, remaining a uniform pale grey regardless of the changes in the load.

WORKS MANAGEMENT AS A CAREER.

An address on "Works Management" was given by Sir Holberry Mensforth, K.C.B., to the graduates and students of the North-Western Section of the Institution of Mechanical Engineers at the Engineers' Club, Manchester, on Thursday, the 31st ult. Sir Holberry divided the subject into three broad headings—(1) the need, (2) the faculties and training to fulfil the need, and (3) its possibilities.

He said that the need was felt owing to the change in manufacturing methods, brought about by the development of engineering; the increase in scientific and technical knowledge; the better, or more widely, spread general education of the industrial population; the demand for a higher standard of living not only outside the factory, but within its walls; the influence of the Factory Acts and similar legislation on workshop problems; the spread of democratic ideas as to the workman's place in industry; the need for maximum efficiency in all manufacturing operations to enable the maximum amount to be distributed in wages; the need for some substitute for the personal touch between the employer and the employed which had been lost during recent years owing to the merging of individual concerns into a number of large corporations; and the tendency during recent years to neglect the productive side of industry for the distributing side.

With regard to the faculties and training, Sir Holberry mentioned good health; willingness to do more than one appeared to be paid for at the moment; faith in the honesty of purpose of the majority of one's fellowmen; and the capacity to appreciate "the other fellow's" point of view.

Sir Holberry said that any reasonable system of training could give, and had given, good results, but none of them could be substituted for experience. Too many young men considered themselves "learnt" up when they left school or college, when, as a matter of fact, at that point they had only purchased their tools and had yet to learn how to use them. An academic degree was of no value so far as management was concerned, except as evidence that the holder had had opportunities of studying the fundamentals of his profession and had profited by them so far as that could be proved by examination.

Sir Holberry especially advised young men to develop

their capacity to assimilate and analyse vital statistics of cost, production, &c. At no time in the past had the necessity been so great as it was to-day for a real knowledge of what was meant by the cost of a product and for a proper appreciation of how that cost was made up. To attempt to run an industrial establishment without information as to how the money was spent was as bad as trying to navigate a ship without chart or compass. The accounts side of engineering had been too long neglected by the engineer, and he recommended that a course of industrial accounts should be included in the training curriculum of any engineering college. It might well be considered in connection with admission to the Institution.

Repair and Upkeep of Pneumatic Tools.*

By R. W. WILSON, of Newcastle-on-Tyne.

THE scope of this paper is to consider what is necessary to maintain in efficient operation and in economical service the pneumatic tools commonly used in engineering workshops and shipbuilding yards. These tools may be roughly divided into two classes, namely, reciprocating tools or pneumatic hammers, and rotating tools or pneumatic drills. Pneumatic tools are used in rough surroundings, and are operated by men who would also, perhaps unthinkingly, be characterised as rough. They must, therefore, be rough and strong externally so that they can withstand the most strenuous use and unlimited abuse, yet in the details there are scarcely any machines so carefully made and so precisely sized in all responsible dimensions. The readiness of compressed air to leak away wherever it finds a chance is notorious, and yet the cylinder-heads, the valves and other parts requiring air-tight joints are so perfectly surfaced and fitted that they go together and are always used metal to metal absolutely without packing.

Every part of a standard pneumatic tool is so accurately made to gauges that stocks of parts are maintained and these pieces can always be relied on to interchange with and replace each other. The manufacture of these tools requires the coincident compliance with many exacting conditions; the trying out of successful details of the design, the relative areas of ports and passages, the sizes of the several parts for this material co-operation, the selection of the most suitable and enduring materials for each part and their proper heat treatment and manipulation to secure strength and slow-wearing qualities. This means carefully selected, trained and long experienced workmen; installation of automatic and often special machinery, costly collections of gauges, jigs and original tools for special operation; the testing and the rigid inspection of the product before it is sent out.

The efficient operation of these machines should be facilitated by ensuring a good supply of air, free from moisture, convenient hose connections, means for keeping the pipe-line free from ice, and provision for oiling the machines as required. Efficient and economical service demands that riveting hammers shall have sufficient speed and power to drive the rivet while it is still hot; that they do not vibrate or kick to an extent that makes it difficult to guide, and that they shall respond to the throttle promptly, giving light or heavy blows as desired under the full control of the operator.

The pneumatic tool room and stores should be supplied with spare parts and be able to supply promptly such accessories as experience has shown are necessary. The most trifling faults are liable to throw these tools into disorder, which either reduces their power or causes them to kick and stick or start badly. The repair man should be competent to remedy such defects with a minimum of delay. Only a small percentage of repair men ever learn exactly why or how these tools operate, but if they remember that they worked properly when they left the factory, and learn to keep them in their original condition, it is all that is necessary. As tools come in for cleaning the repairer should check their air consumption by comparison with a standard tool, examine carefully the surfaces which are supposed to fit together with an air-tight joint, remove any burrs with a very fine flat file, take away the sharp corners and countersink the pin-holes slightly.

The repair man should try, on a heavy block of wood arranged for this purpose, one of the hammers which is known to have sufficient power and to work smoothly. With the working characteristics of this hammer as a standard, he will soon learn how fast a tool ought to run, how much vibration is to be expected under normal conditions, and how rapidly the sett ought to cut into the wood when the tool is developing normal power. With these standards in mind he can test doubtful tools, and judge by comparison whether they be right or wrong. A good repair man will soon be able to state positively whether they be right or wrong, and readily diagnose faults.

The lubrication of pneumatic tools must be done judiciously. For pneumatic hammers, on no account must heavy oils be used; these tend to gum up the valves and may prevent the tools from working. A light machine oil is the best to use. The way to oil the tool is to pour a little light machine oil into the air-supply passages or opening before connecting on to the hose. When the tool is started the air will carry this oil into all working parts, and while the tool continues at work no further lubrication is necessary. It is desirable that every pneumatic hammer in use should be immersed occasionally in a bath of mineral oil for a thorough cleansing, and if a tool has been lying in store for a period it should be also immersed in the oil bath previous to use and then lubricated as already described.

Important economies can be effected by paying careful attention to such matters as the sorting, cleaning, testing, maintenance of pneumatic efficiency, the carrying out of minor repairs, and lastly the system adopted of issuing the tools to the operators.

It has already been pointed out that, taking it all round, no tools are subjected to more abuse than pneumatic tools, and anything that can be done to check that abuse is money twice saved. Money saved by the prevention of breakdown is far better than any system of repairing, however perfect. That tools, subjected to the severe stresses of pneumatic tools, should break down occasionally is not to be wondered at; it would be remarkable if they did not, but it is astonishing how the life of a tool can be prolonged by the exercise of care in use and keeping.

It is not sufficient for the foreman or chargeman to rate a workman soundly for carelessness when a tool is broken or lost. The only way is to make a workman responsible for the tools he is using by touching his pocket, and any economical system of tool issue must take this basic fact into consideration, even up to the extent of making an operator pay the full value of the tool broken or lost. Admittedly any system of the kind that penalises an operator is very difficult to introduce, but it can be done by the exercise of tact, and in the yard the author has in mind such a system was introduced and accepted by the men in the difficult labour period immediately following the war. In this yard every user of pneumatic tools is given a book when he starts work. On the book is printed the name of every pneumatic tool he is likely to use; a corresponding card, indexed under the Workman's Board No. is retained in the pneumatic tool store. The workman starts his career by obtaining from his foreman a requisition for the tools he first needs. These are entered in his book and in the tool store record; thereafter by producing the book he can exchange at the pneumatic tool store one tool for any other he may be in need of without reference to his foreman. All pneumatic tools are numbered also pneumatic hose lengths ready fitted with connections. In addition to his book, a workman is also provided with a number of checks, one of which he gives in to the pneumatic tool store whenever he gets a tool out. At the end of every week a workman must clear his machines and receive from the store foreman a chit to this effect before he can receive his pay. If for any reason a tool is not returned, or a tool is returned broken, the pneumatic store foreman gives to the workman a red slip with the value of the tool or damage entered thereon as a deduction from his pay. This rule is very strictly observed, making it impossible for a workman to receive his full pay until he can hand in a clearance note from the pneumatic store foreman. Deductions made from the workman's pay are, of course, refunded if afterwards the tool or part that is missing is found and returned to store. The justice of this is appreciated by the workmen and gives them confidence in the system.

Before being put away, all tools are carefully tested to ascertain that they are in good working order, especial watchfulness being exercised in checking air consumption. Any tools observed to be consuming more air than the standard are immediately put into the repairer's hands to be tuned up and have worn parts replaced. Accurate costs of repairs are booked against each individual tool, and these are classified under the different makes of tools in use, the result being a very complete record showing the repair cost of the tools obtained from different manufacturers. The accompanying table gives such a record over a period of twelve months. The different makes of tools in use are indicated by letters, and the table is interesting as showing the great difference in the cost of upkeep of tools from various makers.

Accurate records must be kept of the power costs of running the compressors, which usually are easily obtained from the electric meter readings, and the maintenance cost of the plant. In a large shipyard on the North-East Coast, the actual cost of compressing 100,000 cubic feet of free air to 100 lb. per square inch pressure with electric current at 1d. per unit worked out as follows:—Power, 20/1d.; circulating water, 3d.; labour, 6·2/3d.

In a well-maintained plant there must be no leakages. Leakages are most usually found in the flexible hose lines and connections. If left to themselves workmen will suffer leaks which cause them no inconvenience rather than stop their work for the purpose of obtaining a new hose-line. Where a number of tools are in use it is an economy to employ a man whose duty it is to go round inspecting the pipe-lines, rewiring on leaky connections, and on occasion purposely to cut a leaky hose-line to compel a workman to go to the store for a new length of hose.

Another fault which is often met with is loss of pressure at the point where the tool is used. Nothing is so fatal to the efficiency of pneumatic tools as a drop in the air pressure. Pipe-lines are sometimes overloaded and too many tools are supplied from a main much too small in diameter. Tables are given in text-books as to the size of main to employ, and it is but poor economy to permit a drop in pressure of, perhaps, 20 lb., or even 30 lb., due to small mains. Another fault frequently met with is the throttling of air in the connections. Some connections are very bad in this respect. It is not an uncommon thing to fasten two lengths of hose with a connection having a hole perhaps less than half the area of the hose-pipes connected, or, maybe, a cheap connection is used for connecting with the service pipe with a cast hole through it rough and half closed. It pays to have machined holes through connections made as large as possible compatible with the strength of the couplings.

Another source of trouble which requires careful watching are strainers. They are very necessary sometimes, especially in dirty or dusty places, but they are liable to get choked up at times very quickly. Makers usually fit strainer adaptors to all tools, and it not infrequently happens that a mysterious loss of power in a pneumatic tool may be traced simply to the gauze in the strainers getting choked up with dirt. These strainers are very easily cleaned by blowing air through the opposite way.

Water in the pipe-line is a frequent source of trouble. This is generally due to the after-coolers and air receivers being too small, the hot air from the compressors not being properly cooled before entering the main. A good remedy for this is to introduce water traps in suitable places

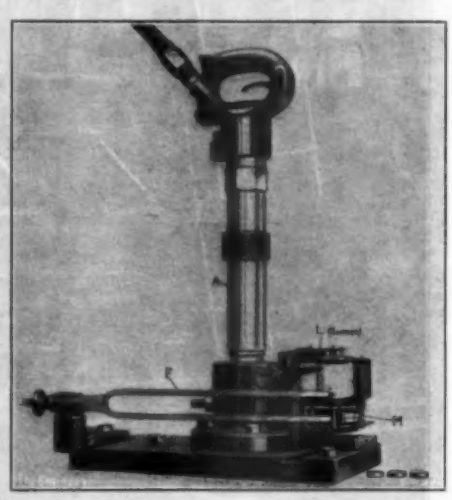


FIG. 1—TESTING MACHINE FOR PNEUMATIC HAMMERS

in the pipe system, and at these traps the water can occasionally be blown out. Moisture tends to choke the tools, and not infrequently causes ice to form in the valves and at the exhaust; also, it always tends to rust the internal parts of the tools, and thus may cause much damage. Water in the pipe-line collects at low bends and angles, and besides stopping the free flow of the air, in cold weather is very liable to freeze.

In order to ascertain the real worth of a pneumatic tool, it is obvious that some ready means of comparing one tool with another is essential. Opinions of workmen as to the merits of any particular make of hammer are largely influenced by prejudice, and the hammers they are accustomed to operate. In comparing hammers the following are points to which consideration must be given:—

(1) The actual time in doing a definite amount of work, say, closing a rivet; but to compare hammers in this way a knowledge of the weight and frequency of the blow is essential.

(2) Freedom from vibration, which enables the operator to use the tool for longer periods without undue fatigue.

(3) The weight, in order to avoid tiring the workman, by having to hold up a heavy tool.

(4) Flexibility and ease of control, so that light and heavy blows may be struck at the will of the operator.

With pneumatic drills comparisons are usually made by simple timing when drilling a definite diameter and depth of hole through a mild steel plate.

The machine shown in Fig. 1 was designed by the author as a ready means of comparing the weight and frequency of the blows of pneumatic hammers, and, as a result of many hundred of tests done on the machine, interesting results have been obtained. The weight of the blow is ascertained by gauging the crushing effect on prepared

Table giving Details of Working Costs.—Average Maintenance Cost for Drillers, Caulkers, Riveters, Pneumatic Machines for the Year 1922.

Effective Nos. of machines	Description.	Age of machine.	Number repaired	Cost of time, 12 months.	Cost of material, 12 months.	Total cost, 12 months.	Cost of one for 12 months.	Revs. per minute	Air free consumption.	Weight of machines
	Drillers.			£ s. d.	£ s. d.	£ s. d.	£ s. d.			lb. oz.
79	No. 2 N.R. A ..	1911–1920	246	108 16 3½	550 8 6½	659 4 9½	2 13 7	339	35	35 0
17	No. 2 Rev. A ..	1911–1920	48	9 18 7½	65 5 1½	75 3 8½	1 11 3½	420	50	35 0
54	No. 4 A	1911–1919	283	78 6 0	428 6 11½	506 12 11½	1 15 9½	582	36	27 0
15	No. 2 B	1920	55	20 7 8½	132 19 2½	152 16 10½	2 15 0½	368	40	40 0
26	No. 3 B	1920	102	39 0 2½	102 17 5½	141 17 8	1 7 9½	556	30	23 8
46	No. 5 B	1920	129	30 10 7½	93 8 7½	123 19 3	0 11 4	699	28	14 4
29	No. 9 B	1920	95	32 8 6	123 17 10	156 6 4	1 12 10½	136	42	38 0
	Riveters.							*Blower.*		
4	No. 9 C	1910–1911	9	1 14 1	3 14 8	5 8 9	0 12 1	750	25	26 0
90	No. 5 combination JB D ..	1915–1920	321	95 4 4½	245 8 7½	340 13 0	1 1 2½	1000	37	34 0
22	Holder on E ..	1912	7	0 12 3½	2 3 0	2 15 3½	0 7 10½	—	—	25 0
32	Baby JB F ..	1912	40	9 3 0	11 3 3½	20 6 3½	0 10 1½	800	48	40 0
24	No. 4 H	1912–1919	4	0 5 6	0 4 0	0 9 6	0 2 4½	1000	25	15 0
44	No. 5 H	1912–1919	171	31 12 3½	75 15 4½	106 7 8½	0 12 5	1060	24	21 0
17	No. 6 H	1919	65	10 19 3	64 19 3½	75 18 6½	1 3 2½	760	26	23 4
12	No. 8 H	1919–1920	53	8 2 5½	43 13 5½	51 15 10½	0 17 10½	700	30	24 8
33	No. 4 G	1914–1919	102	38 14 9	228 16 10½	267 11 7½	1 13 0½	800	24	17 8
68	No. 6 W	1920–1921	253	77 13 1½	65 0 5½	142 13 7½	0 11 3½	1500	26	17 8
4	No. 5 W	1920	7	0 19 1½	0 5 0	1 4 1½	0 3 5½	1760	19	13 4
	Caulkers.									
14	K	1916–1920	33	24 7 9½	46 1 2	70 8 11½	2 2 8½	2800	20	16 8
79	No. 2 M	1913–1919	262	42 4 10½	157 11 10½	199 16 8½	0 12 11	2800	20	16 8
		Totals ..	2345	661 0 10	2442 0 9	3101 11 7½				

* The Institution of Mechanical Engineers.

test pieces in given periods of time and the frequency of the blow by comparing the wavy line produced on a moving strip of paper by the action of the hammer, with a similar wavy line produced on the same piece of paper by a tuning fork of known vibrations.

The test pieces, which are illustrated in the upper part of Fig. 2, are made of mild steel. They are usually ¾in.

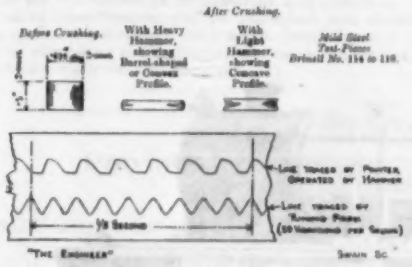

After Crushing.
Before Crushing.
With Heavy Hammer, showing Barrel-shaped or Convex Profile.
With Light Hammer, showing Concave Profile.
Mild Steel Test-Pieces Brinell No. 114 to 118.
LINE TRACED BY PENCIL OPERATED BY HAMMER
LINE TRACED BY TUNING FORK
½ SECOND
"THE ENGINEER"

FIG. 2

diameter by ¾in. long, ground to a limit of 0.0005in. in both dimensions and made from mild steel of hardness equal to Brunel test No. 114 to No. 118. The test piece is placed in the cylinder marked A on Fig. 1. The strokes of the hammer are recorded on the strip of paper by the movement of the pencilled lever L, and on the same strip of paper are likewise recorded the oscillations of the tuning fork F, the strip of paper being made to travel by the clockwork mechanism M. In the lower part of Fig. 2 strips of paper are shown with the two wavy lines, one made by the hammer blows and the other by the tuning fork vibrations. Views of other test pieces are also given in Fig. 2—to illustrate the crushing effect of the hammer

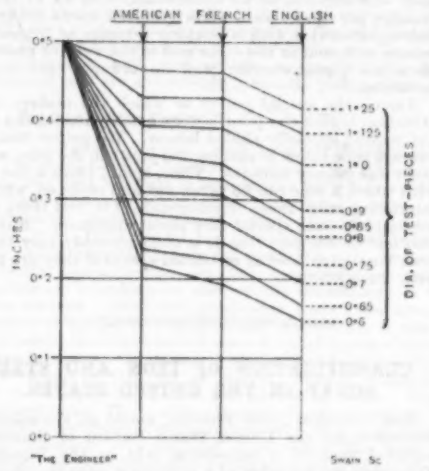


FIG. 3

blows. It is interesting to note that the edges of many of the crushed test pieces are quite different in shape. Some assume a barrel or convex profile, while others are pin-cushion or concave shape. It was found by experiment that either shape of crushed test piece could be produced by changing either the weight of the hammer used or varying the diameter of the test piece. The results showed that the convex shape of the test piece was produced when a heavy hammer was used, and the concave shape was produced when a lighter hammer was employed. Further, this difference in shape was sometimes produced with hammers of the same rated capacity operating on similar test pieces, although the measured distortion on the test

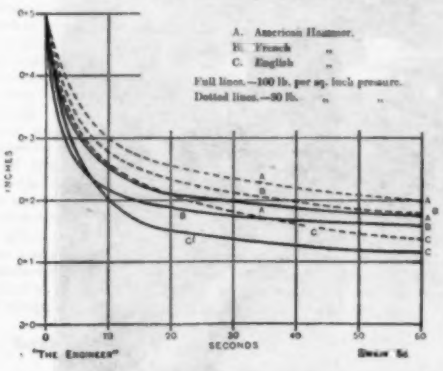


FIG. 4

piece might be approximately the same in the two cases. The hammers with the slow beat usually gave the convex form, while the hammer with the quicker beat and lighter blow gave the concave form of crushed test piece. It is clear that the convex form of test piece reproduced the conditions when a rivet is set up in the hole, such as is usually required when cup riveting on structional work is done, and that the concave form of test piece reproduced the conditions required for flush riveting work, where it is important to spread the rivet head quickly, such as shell riveting on a ship. This indicates how important it is that the weight of blow or size of any hammer should be suited to the class of work it has to do.

Very large numbers of tests have been made on this machine, and the table and diagram given will be of interest as showing a comparison between different makes of hammers. The hammers selected for comparison are all new tools. One is an American hammer, the second a French hammer, and the third an English hammer. Makers' names are purposely omitted, but the English hammer is of the author's own design.

Other tests were carried out with a view to ascertaining the amount of distortion on test pieces of different diameters in an equal period of time of 20 secs. These test pieces may be likened to rivets of different diameters, and it is interesting to compare the upsetting effect of different hammers. The measured distortion taken in conjunction with the final shape profile truly indicates the most suitable hammer to use on any particular size or class of rivet. These results are plotted in Fig. 3.

Further series of tests were made with a view to ascertaining the cumulative effect on a test piece when subjected to repeated hammerings. A standard test piece, 0.625in. by 0.5in. long, was selected, and after every 10 secs. of hammering was taken out of the machine, gauged to measure the distortion and put back again. The results are plotted in Fig. 4. The same three riveting hammers were again employed as in the above test, and the tests were made at both 100 lb. and 80 lb. air pressure. The distortion is rapid at first, but after 20 secs. reduces until between 50 secs. and 60 secs. very little further distortion takes place. An obvious lesson demonstrated by this diagram is the importance of having rivets the right length. If rivets are left a little too long, it is clear that it must be impossible to close them properly. Another rather remarkable result shown by this diagram is the very great loss in efficiency when the air pressure is dropped from 100 lb. to 80 lb. It clearly shows that the same amount of distortion can be produced on the test piece in about half the time with air at 100 lb. than with air at 80 lb., and as only about 10 per cent. more power is required to produce compressed air at 100 lb. over compressed air at 80 lb. It indicates how very important it is to use the maximum air pressure at which the tools are designed to work to attain the best results. Further, when it is considered that most pneumatic riveting is hot riveting, and the rivet all the time is rapidly cooling, the importance of maintaining high air pressure at the point where the tool is to be used connot be over emphasised. This is indeed the crux of obtaining quick and sound work, and when these conditions prevail, there is no fear but that pneumatic riveting will beat hand riveting, not only as regards time, but as regards the quality of the work produced.

MANCHESTER ASSOCIATION OF ENGINEERS.

THE annual dinner of the Manchester Association of Engineers was held at the Midland Hotel, Manchester, on Friday, 8th inst., under the chairmanship of the President, Mr. Cecil Bentham, M. Inst. Mech. E. There were nearly 180 members and guests present. The toasts were few, and the speeches above the average in merit, for such occasions. In proposing the toast, "The Manchester Association of Engineers," Sir Max Muspratt, Bart., Vice-President of the Federation of British Industries, referred to the present day tendency of excessive specialisation in industry. He described engineering and chemistry as sister industries and rulers of the world. He said that by over-specialisation in these industries there was a liability to take too narrow an outlook. The different industries to-day must get closer together, as their future success was dependent upon co-operation. Labour had learned to organise and study industrial problems much more efficiently than the employers. Those in charge of industries must, therefore, follow labour's example. In reply to this toast, Mr. Cecil Bentham confirmed Sir Max Muspratt's appeal for the need of more co-operation amongst the industries. He also made special reference to the students' section of the Association, which was formed only a few years ago, saying that owing to the difficulty which many of the students had experienced in finding employment during the long spell of slack trade, the council had decided in some cases to remit the subscriptions of the junior members in order to retain their interest in the Association. The toast "Our Guests" was proposed by Alderman Fred. J. West, C.B.E., M.I. Mech. E., and responded to by Lieut.-Colonel J. Nall, D.S.O. Mr. Daniel Adamson, M.I. Mech. E., was responsible for the toast of the Chairman, which was carried with musical honours. A very pleasing feature of the evening's proceedings was the entertainment provided between the speeches by Mr. Livingston Eccles and Mr. Hamilton Harris.

THE NEWCOMEN SOCIETY.

A MEETING of the Newcomen Society, on Wednesday, the 6th inst., was devoted to the reading and discussion of short papers in the congenial atmosphere afforded by Prince Henry's Room, Fleet-street.

The first paper, on "A Chain of Pots, Sixth to Seventh Century A.D.," was read by Mr. G. F. Zimmer, A.M. Inst. C.E., who recited an agreement recorded on a Coptic papyrus of that date preserved in the University of Basle. Fortunately for his audience, the author did not attempt to give the Coptic original, but from the translation it was evident that this "chain of pots" of the sixth or seventh century could be taken from place to place wherever irrigation was wanted. The rent for its use was to be 19 measures of wheat.

The second paper, also by Mr. Zimmer, was based upon a sketch, copies of which were passed round, to which his attention had been drawn by one of the members of the Society, giving an artist's representation of a dredger of the chain pump type used in the Low Countries. The sketch was, in the opinion of experts, from the hand of Pieter Brueghel the Elder, and of date 1560. The author had arrived at the opinion that the dredger was warped along the river, and that the chain of buckets was actuated by the float wheels dipping in the stream, assisted by men treading on the rungs. In the discussion that ensued, doubt—a characteristic frame of mind in the Society—was thrown upon the sufficiency of the power available to actuate the ponderous machine.

The third paper was on a sixteenth century treadwheel for raising water, which is still in existence beside a farm-house at Great Kewland, near Maidstone. The author, Mr. H. A. Sandford, B.A., F.G.S., said that the date upon the house was 1579, and there was every appearance that the wheel chamber and the wheel were original parts of the house. Exceptional means, such as this wheel, were required to draw water because of the depth of the well, viz., 96ft. A drawing and a photograph of the wheel were shown. Discussion turned on the methods of construction adopted by the millwrights of the period, and whether the wheel was as old as the author believed it to be. It came out that quite a number of such wheels are still in existence.

The last paper was by Mr. A. F. Sieve-King, F.S.A., on a MS. preserved at the Royal Society's Rooms. It was written by John Evelyn, of "Diary" fame, is entitled "A Circle of Mechanical Trades," and is dated 1660. It was not generally known how wide was Evelyn's scientific range. At the date named, the Society was fostering the study of mechanics; hence the proposed work. Its interest to-day was the list of trades catalogued, some of them now extinct. In the author's view, they were all English trades of the day. The consensus of opinion was that the MS. ought to be printed.

SIXTY YEARS AGO.

IN the early days of 1864, according to a statement in our issue of February 12th for that year, Britain's armour-plated Navy consisted of ten iron frigates afloat, six nearly ready, and five in various stages of construction. A protest was added against the Admiralty's practice of armour-plating wooden-built ships. In the case of the Lord Warden and the Lord Clyde, then under construction, it was estimated that a saving of £10,000 would be effected by having a wooden frame and a loss of £200,000 incurred by the speedy decay of the wood as compared with iron. We recorded the launch of H.M.S. Enterprise at Deptford. This small armour-plated vessel, it was stated, had proved her strength to be unusually great, as she had not "broken" in the slightest degree during the launch, whereas the greater number of ships of her size broke from ¼in. to ½in. Another item of nautical interest was recorded in a paragraph entitled "An Interesting Relic." It was therein stated that at that moment there was in Deptford Dockyard a model, constructed in 1558, of a yacht built for Queen Elizabeth. The model, it was added, was in an excellent state of preservation, and had come into the possession of Mr. Brown, of the dockyard, at the sale of the effects of a naval officer. . . . In the course of his presidential address before the South Wales Institute of Engineers, Mr. Alexander Bassett gave a graphic account of the sombre conditions attending coal mining in Scotland previous to the year 1800. The collier and his sons, if he had any, left home at about eleven in the evening and, proceeding to the pit, "prepared the coals by hewing them down from the wall." His wife and daughters followed him three hours later and descended the pit with baskets. When the baskets had been filled the women proceeded to carry them on their backs to the pit bottom, the mother going first with a lighted candle held between her teeth. From the pit bottom they carried their loads up the steps to the top, where they laid the coals out for sale. In the course of eight or ten hours one woman might carry a total load of 2 tons, traversing a total distance of nearly 6 miles and ascending over 100ft. by the stairs twenty-four times. That the collier's life was less arduous when Mr. Bassett spoke than at the beginning of the century is, of course, certain, but that it was less dangerous is less clear. According to a note elsewhere in the same issue, 1133 lives were lost in British coal mines in 1862. That year covered the terrible disaster at Hartley colliery, when 209 persons were killed. The sympathy excited throughout the kingdom in connection with this disaster resulted in over £80,000 being subscribed in relief of the sufferers' families—a sum so far in excess of the "reasonable requirements" of the case that an arrangement had to be come to for varying the application of the surplus.

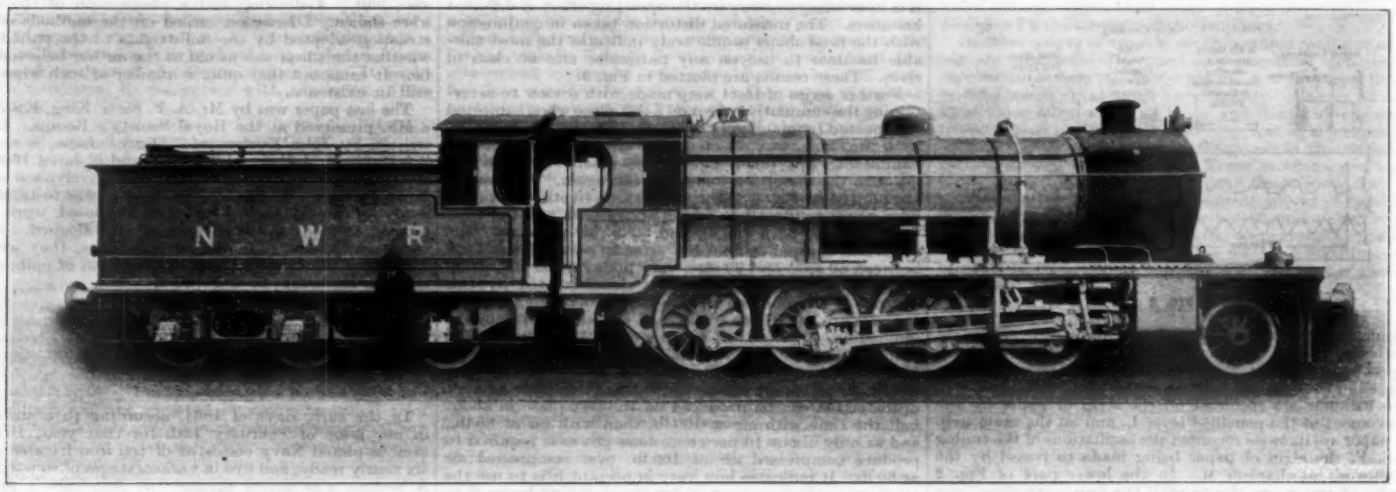
CATALOGUES FOR JERUSALEM.—The Director of Public Works, Russian Buildings, Jerusalem, desires to receive regularly from manufacturers catalogues, price lists and other advertising literature, concerning all kinds of plant, tools, instruments and materials requisite for general public works, including road building, water and electricity supply, building construction, drainage, &c.

ACCIDENT PREVENTION.—The Industrial Welfare Society, of 51, Palace-street, Westminster, has just issued a memorandum on the prevention of accidents in factories which has been prepared with "the object of placing before industrial firms the fundamental principles of organised accident prevention, and of outlining some plans for putting into operation effective campaigns." It is the accepted view that interest in accident prevention can only be maintained by a constant stream of posters, films, slogans, &c., and we learn that the Society, by special arrangement with the National Employers' Mutual General Insurance Company, is in a position to provide material of the kind. The purpose of the publication is to show how such and other material may be used to the best advantage.

INTERNATIONAL CONGRESS ON ARCHITECTURAL EDUCATION.—The arrangements for the International Congress on Architectural Education, which will be held at the Royal Institute of British Architects, from Monday, July 28th, to Friday, August 1st, 1924, are in the hands of an Executive Committee under the chairmanship of Mr. Maurice E. Webb, M.A. The following have consented to serve on the Committee:—Sir Reginald Blomfield, R.A., Sir John J. Burnet, A.R.A., Lieut.-Colonel H. P. L. Cart de Lafontaine, Mr. Arthur J. Davis, Mr. G. Topham Forrest, Mr. W. Curtis Green, A.R.A., Mr. Stanley H. Hamp, Mr. Arthur Keen, Professor Beresford Pite, Mr. W. S. Purchon, Professor C. H. Reilly, Professor A. E. Richardson, Mr. Howard Robertson, Mr. H. D. Searles-Wood, Mr. Evelyn Shaw, and Mr. Paul Waterhouse. Mr. Henry M. Fletcher is the hon. secretary. The Congress will consist of meetings for the reading and discussion of papers, visits, receptions and a dinner. An exhibition of students' work will be held, and it is hoped to be able to arrange for accommodation for the exhibits in Devonshire House, Piccadilly, in addition to the galleries of the R.I.B.A., 9, Conduit-street, W. 1.

NORTH WESTERN RAILWAY OF INDIA, EIGHT-COUPLED GOODS ENGINE

THE VULCAN FOUNDRY, LIMITED, NEWTON-LE-WILLOWS, ENGINEERS



Goods Engines for India.

OUR illustration represents one of a batch of fifty-five 5ft. 6in. gauge goods engines and tenders fitted with superheaters, which have recently been built by the Vulcan Foundry, Limited, Newton-le-Willows, for the North-Western Railway of the Indian States systems. They are of the 2–8–0 type and have six-wheeled tenders. The following are their leading particulars :—

Cylinders.

Cylinders, diameter	22in.
,, stroke	26in.
Valves—piston.	

Boiler.

Shell diameter (inside)	5ft. 6in.
,, length	12ft. 6in.
Plates (thickness)	⅞in.
Working pressure	160 lb.

Copper Fire-box.

Length (inside at top)	7ft. $6^{7}/_{16}$in.
Width ,,	4ft. 10⅛in.
Depth (front)	6ft. 7in.
,, (back)	5ft. 11in.
Plates, thickness	$^{9}/_{16}$in.
,, tube, thickness	1in.

Tubes.

134 tubes (diameter outside)	2¼in.
28 smoke tubes (diameter outside)	5½in.
Length between tube plates	13ft.
Heating surface.	sq. ft.
Fire-box	172
Small tubes	1026
Smoke tubes	494
Total	1692
Superheater	390
Grate area	32 square feet.

Driving Wheels.

Diameter on tread	4ft. 8½in.
,, of centre	4ft. 2½in.
Journals	8in. by 9in.

Pony Truck Wheels.

Diameter on tread	3ft. 7in.
Journals	6½in. by 9in.

Wheel Base.

Rigid	16ft.
Total (engine)	23ft.
Total (engine and tender)	50ft. 4½in.

Brake.

Engine	Automatic vacuum.
Tender	Automatic vacuum.

Weight.

On drivers	64¼ tons.
On pony truck	8¼ tons.
Total (engine)	72½ tons.
Total (engine and tender)	120 tons.

Tender.

Diameter of wheels	3ft. 7in.
Journals	6in. by 11in.
Tank capacity	4000 gallons.
Fuel capacity	7½ tons of coal.
Tender, loaded	47½ tons.

THE INSTITUTION OF PUBLIC LIGHTING ENGINEERS AND SUPERINTENDENTS.

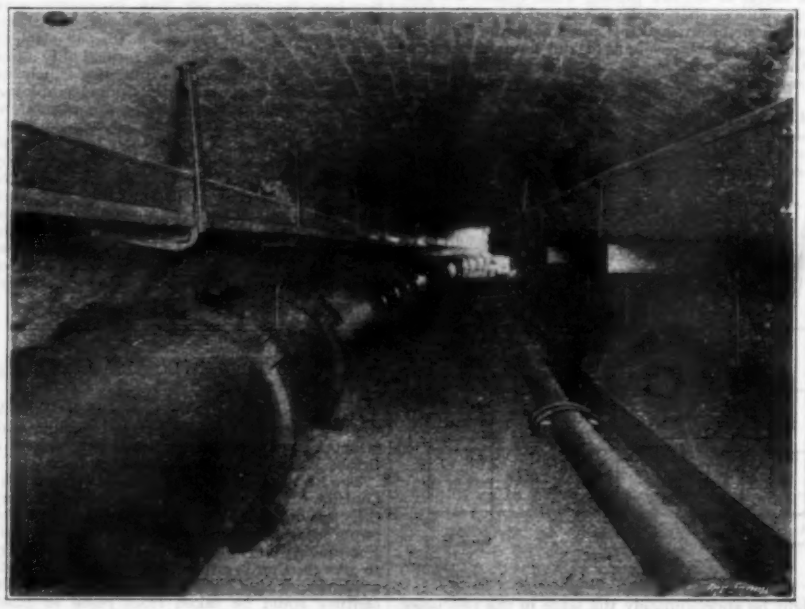
THE Institution of Public Lighting Engineers and Superintendents is holding a first Conference and Exhibition of some of the most modern street-lighting appliances this afternoon at 2 p.m., in the Court Room of the Holborn Borough Council offices, 157, High Holborn, London, W.C. This Institution, which was formed in September last, was brought into being to fill the great want of an organisation for all those who are directly concerned with the practical side of public street lighting. Up to now there has been no institution or other place where such officers could, by the reading of papers and discussions thereon, elucidate the many problems which present themselves day by day. It was felt, too, that by its aid visits of inspection to various towns and to factories and works where appliances in connection with street lighting are manufactured could be arranged so that its members could become acquainted with the best systems of gas, electric and other forms of lighting, and thus be enabled to advise their authorities as to what are the best apparatus and methods to adopt, and those which will give the greatest illumination with the least expenditure. The first President, Mr. S. B. Langlands, the public lighting superintendent of the City of Glasgow, who will preside at the Conference, will deliver his presidential address, and a short paper on street lighting will afterwards be submitted by Captain W. J. Liberty, public lighting superintendent of the City of London, in connection with which there will be a demonstration of the centrally suspended high-power electric and gas lamps in the City, and an inspection of the public lighting of the Metropolis.

Further particulars of the Institution may be obtained from Captain W. J. Liberty, hon. secretary and treasurer (*pro tem.*), care of Public Lighting Office, Guildhall, London, E.C.

Water Main with Flexible Joints.

A VISIT of inspection to view a water main which has recently been laid in a subway running from Tooley-street, London Bridge, to Westminster Bridge, was arranged last week by the Victaulic Company, Limited, of 28, Victoria-street, Westminster, S.W. 1. The pipe, which is illustrated in the accompanying engraving, is 36in. in diameter, and it forms a balance main between two different water systems. It is fitted with the Victaulic system of flexible joints, with which our readers are familiar. It may be said here, however, that the joint is formed by a specially shaped rubber ring, which embraces shoulders left on the pipe ends, and which is held in position by a cast iron ring, which is formed of sections bolted together. The ends of the pipes are not butted together, but a small space is left between them, so that not only can the pipes expand and contract freely, but it is possible to lay them on the curve of reasonable radius without having to make special pipes. The pipe shown in the illustration is, it will be observed, laid on a curve. The shape of the rubber ring is such that internal pressure in the pipe tends to increase its grip on the pipe ends, and it is claimed for the joint that it is absolutely leakless, whether water or gas is being conveyed in the pipes, and even when subjected to severe vibration or subsidence. It is, for instance, being used with success, so we understand, with air at 250 lb. pressure per square inch, while hydraulic mains are giving leak-tight service with a working pressure of 2 tons per square inch, and at the other end of the scale of pressure, there are pipes working well on ordinary gas supply networks.

Among the special points to which the makers draw attention is that the joint is very quickly made, and does not require specially skilled labour. We gather that the average time taken in making the joints in the 36in. water main was twenty minutes. Then, again, there is the ease with which a pipe can be taken out and replaced, without interfering with those on either side of it, and there is no necessity to take special care about alignment. Stress is also laid on the fact that it is comparatively easy to run even large pipe lines in restricted spaces if they are fitted with these joints.



36in. VICTAULIC WATER MAIN IN A LONDON SUBWAY

CLASSIFICATION OF IRON AND STEEL SCRAP IN THE UNITED STATES.

THE *Technical News Bulletin*, issued in the middle of December by the United States Bureau of Standards, reported that at a conference held at the Bureau in November the adoption of a uniform master classification for iron and steel scrap was discussed. Representatives of many prominent industrial associations and Government Departments were present. Mr. G. C. McClure, of the National Association of Purchasing Agents, submitted for consideration a classification drawn up by a Sub-committee of that Association. This classification included six major divisions, as follows :—Specifications covering scrap for use in (1) blast-furnaces, (2) basic open-hearth furnaces, (3) acid open-hearth furnaces (this scrap being of low phosphorus and low sulphur content), (4) electric furnaces, (5) gray iron foundries, and (6) Bessemer converters. A seventh classification to include scrap for use in the manufacture of wrought iron was considered desirable. It was the concensus of opinion that a national classification should cover the material when broken down ready for the furnace, and should not go into details as to the various items composing the scrap.

These details, it was decided, should be left to the purchaser's selection, according to his individual requirements.

The discussion brought out the fact that much more work will be necessary before the classification can be finally agreed upon. This work will be carried out largely through correspondence, the Bureau acting as a clearing house for the exchange of comment and criticism. The tentative classification will be published and circulated among those interested, and when finally agreed upon will be submitted to the Bureau of Standards for indorsement as a national classification.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

A Quiet Market.

THE market position remains much as last week, no great volume of business passing in any department. Hand-to-mouth buying persists, and there is little sign of any new momentum. The menace of labour disputes is causing anxiety, and the very low prices at which foreign material is being offered has checked the giving out of new work, the impression being that lower prices must soon be available. The current volume of raw material business, it would appear, is not proportionate to the output of mills, forges and foundries. Consumers are running their plants largely on stock, supplemented in many cases by imports of foreign material. Continental prices this week have an upward tendency, which is a hopeful sign, but they remain so low as to give Midland makers of many descriptions of iron and steel no chance of successfully competing in the open market. The Staffordshire ironworks are now getting specifications in connection with the various wagon building programmes, and are accordingly gradually getting busier.

Pig Iron Values Firmer.

Midland pig iron prices have not followed those of Cleveland in their downward course. As a matter of fact, this week smelters in this district have been enabled in many instances to get slightly improved figures. On Derbyshire and Northamptonshire standard foundry irons from 1s. to 2s. 6d. has in some cases been added. The orders negotiated were for small lots only, however. Forward commitments are not considered advisable. Confidence is lacking in view of the uncertainty of the coke outlook. Increased production costs have already swallowed up pig iron profits, and speculation is rife as to whether the collieries will want to exact higher contract prices when their agreement with the blast-furnace owners is reviewed at the end of March. Present quotations for new business are firm at 28s. per ton at ovens. These circumstances have strengthened smelters' hands in resisting the efforts of pig iron consumers to secure cheaper pig. Business is conducted cautiously. The bulk of business in Derbyshire No. 3 foundry is done round about £4 16s. 6d., with a range up to £4 17s. 6d. Northamptonshire foundry is firm at £4 13s. 6d. upwards, and North Staffordshire at £4 17s. 6d.

Steel Position.

Midland steel works are fairly engaged, and in most cases are not urgently requiring new business, consequently they are giving way only slightly under the severe strain of continental competition. The extremely low prices for Belgian billets at which business was done a fortnight ago are no longer available, quotations having gone up this week to £6 15s. and £6 17s. 6d. delivered, an increase of 5s. to 7s. 6d. per ton on last week's quotations. Some local steel makers are not attempting to meet this competition, and are stated to be asking higher prices than of late. £8 to £8 5s. still remains about the market level, however. The disparity between home and Belgian prices is still sufficiently great to divert a large amount of business abroad. Some fairly good sales of structural steel are being effected in connection with railway and other development schemes. Home prices remain unchanged. Some very low quotations are being named by Belgium for finished material. Joists are being offered at £7 10s. delivered, and small steel bars at £6 10s. Antwerp. Birmingham merchants utilise this material chiefly for shipping direct to foreign destinations, but moderate tonnages are coming over for the restocking of warehouses. Midland works maintain the £10 standard for joists. With regard to steel bars, though the Association basis is unaltered, the price applying to most of the transactions that are going through is about £10 5s. Activity in the tube trade has stimulated the demand for strip, the price for which is firm at about £10 15s.

Scrap Values.

Imports of steel scrap are so heavy that many merchants in this district have been obliged to accept £4 10s. for this material. This is a reduction of 5s. per ton on recent values.

Staffordshire Iron Trade.

The Staffordshire finished iron trade continues on a fairly even course, and with consumptive demand increasing values are upheld. This is even the case in nut and bolt iron in which Belgian competition is extremely severe. Local makers have come to the conclusion that it is hopeless to compete, and they are anxious to recover some of the losses they have already made by accepting unremunerative prices in an endeavour to hold their own in the market. They, this week, adhere to the £11 10s. standard, but they contend that if bars were sold on the basis of costs higher prices would be warranted. Belgian houses this week quote about £8 12s. 6d. for nut and bolt iron, and they are taking a large proportion of the business. Uniformity has not been restored in regard to quotations for crown bar iron. Some producers say that orders are not worth taking at £12 10s.; but that is still the ruling price, though many makers quote up to £12 15s. The maintenance of the marked bar standard at £14 10s. for so long has had a steadying effect all round. Wrought iron gas tube strip continues to appreciate, but mill owners move with caution. There is not much freedom about present bargaining; £13 has been conceded for comparatively small lots.

The Suggested Bolt and Nut Combine.

The exclusive news I was able to give in the Latest News column of THE ENGINEER last week regarding the suggested combine among the All-British makers in the black bolt and nut trade continues to be a matter of much discussion on Birmingham Exchange and in the Black Country towns where the Staffordshire industry is most centred. The whole scheme issues, of course, out of the severe price cutting tactics which have been so marked in the trade for nearly a twelve month past, and also from the conspicuous policy which Guest, Keen and Nettlefolds, Limited, have pursued for some months past of buying up additional large Black Country bolt and nut works, with the view of extending their bolt and nut manufacture. The price cutting which has been going on has now become so serious that there can be no question that unless further heavy losses are to be sustained in the trade, such as have of late been a matter of much concern, an end must be put to the internal competition. Since the South Staffordshire bolt and nut makers apparently are determined that South Wales capital shall not obtain trade monopoly, the only way out of the difficulty seems to lie definitely in the direction of a combine, and it is with this object that certian recent meetings have been held among the makers, of which last week's Manchester meeting, which I reported in the Latest News column, was one of the series. As I said last week, I must repeat here that the chief difficulty lies in the large number of makers in the kingdom, to be exact, 45. It can be easily understood that it is found a matter of considerable difficulty to obtain uniformity of opinion among so many firms. What was accomplished in Scotland three or four years ago by the conversion of the various independent makers there into one existing concern would suggest, however, that it should not pass the wit of man to devise some escape from the present English troubles and the strain which is being felt by certain Lancashire and Yorkshire bolt and nut concerns, is additional evidence to that I have already given of the necessity for relief action. The whole question of selling prices is, of course, closely bound up in the proposition for combination, and if prices of black bolts could this year be restored to a living standard, no part of the kingdom would be more advantaged than the Midlands.

New Works in Australia.

While dealing with the bolt and nut trade I may say that intense interest is still manifested hereabouts in the news sent from Melbourne three or four weeks ago that Guest, Keen and Co., Limited, had determined upon opening up works in Australia. As a matter of fact, I happen to know that just recently, a couple of months or less ago, the managing director of Guest, Keens, Mr. Tom S. Peacock—formerly of F. W. Cotterell, Limited, Darlaston—left this country on a six months' tour, travelling abroad, Melbourne being his first landing point, and it is understood that business as well as pleasure was included in his programme.

£50,000 Redditch Rail Scheme.

Important schemes of improvement in connection with the railway service of Redditch and district have been decided upon by the management of the London, Midland and Scottish Railway Company. The news is very gratifying to manufacturers in that district, who have long felt the need of better railway accommodation. The scheme is of an extensive character, and is estimated to cost between £50,000 and £60,000. Extended facilities are to be provided for dealing with heavy goods traffic to and from the town. The goods yard is to be entirely remodelled. Five extra roads or sidings are to be laid down. A new goods shed will be built occupying the full length of the present yard, and the footbridge is to be extended to Windsor-street. The extension scheme will also involve the widening of the bridge crossing Hewell-road and improvements at the passenger station.

Wagon Order for Smethwick.

The Birmingham Railway Carriage and Wagon Company, Limited, of Smethwick, has received from the Buenos Ayres Great Southern Railway an order for 285 bogie covered goods wagons and 200 bogie high-sided open goods wagons. They are to be of all-steel construction and each will have a carrying capacity of 40 tons.

Metallurgical Appointment.

Mr. J. E. Fletcher, of Dudley, consulting engineer and metallurgical adviser to N. Hingley and Sons, Limited, Netherton Ironworks, and allied firms, has been appointed as consultant to the British Cast Iron Research Association, and in addition to advisory duties in connection with the carrying out of scientific research, will direct special attention to the practical side of foundry development in the manufacture of gray, white, and malleable castings.

Workless.

As I anticipated in my last week's letter, the latest unemployment returns for the Midlands show a considerable fall in the number of workless, the total being lower than the previous week by over 5500, and roughly 600 lower than before the railway strike commenced. This is considered satisfactory evidence of a more healthy tone in the labour market as a whole. The total for the area now stands at 154,418, of which number the Birmingham area is responsible for 37,377.

Furnaces for Steel Works.

My attention has been drawn to an error, due to a slip of the pen, which crept into my letter last week. Under the heading "Important Contracts for Midland Firms," I mentioned that the Wellman, Smith Owen Corporation, Limited, had been awarded a contract for the supply of open hearth furnaces for the Crewe works of the London, Midland and Scottish Railway. Four furnaces were ordered and the capacities were given as being 250 tons and 275 tons. What I intended to write was two of 50 tons capacity and two of 75 tons capacity. As a matter of fact, I now understand that the actual rated capacity of each of the smaller furnaces, which are to be of the basic open-hearth type, is given as being from 40 to 50 tons, while that of each of the larger furnaces, which are to be of the acid open-hearth type, is given as being from 60 to 70 tons.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

THE general character of the iron and metal markets here is still dull and a little depressed. It is rather difficult to say exactly what is the cause, and possibly there are many causes acting together. In the iron and steel trades, no doubt, one reason for grave dissatisfaction is that while demand is weak and tends to lessen, the expenses involved in production show definite signs of increase. In normal times of dull trade there is almost always an opportunity of getting down expenses and preparing to meet any coming fall in the selling prices, but this is not now the case. It seems as though the iron and steel trades of the country were entering upon a time when great ingenuity must be exercised to economise in all directions. Some people are saying that the "Safeguarding of Industries Act," as long as it is on the statute book, could be used—under the "Exchange" clause—to stop the imports of cheap foreign material; but, apart from the question whether this remedy would not be worse than the disease, it is doubtful whether any executive would be bold enough to use that Act as a measure of "protection" so soon after the recent election.

Metals.

The market for standard copper, after losing the whole of the advance so painfully gained during the last fortnight of January, has begun again to move upward, but it is impossible to say yet whether or not this movement will be as futile as its predecessors. So far it may merely be a reflection from the movements in sterling exchange. There would seem to be no definite change, so far as the output and consumption of copper are concerned. Statistics show that the domestic consumption in the United States has been fairly good; and it is the poor condition of European consumption which is the weak spot in the market. Possibly resumption of trading with Russia, if it comes about this spring, may do something to improve the European position; but renewal of business with Russia will be a slow affair in any case. Consumers of copper do not yet show any disposition to buy more than is required for prompt consumption. There has been no change up to the time of writing in the prices for manufactured material. The market for old metals still affords a good opportunity for those consumers who are not too tightly bound down by specifications. Dealers here, for instance, are buying good gun-metal scrap at £45 per ton. Tin has again shown very great strength. The advance since the end of the year now amounts to £32 per ton. It is suspected that recently there has been some artificiality about the advance; and that it has not altogether been caused by small supplies and increasing trade demand. It is, however, very difficult to decide on this point; and at present the rate of consumption is still greater than that of output. The market for lead seems to have been affected by the threatened dock strike, and consumers have been trying to secure a reserve in case deliveries should be cut off for a time. This may account for the recent small advance; but, apart from this, the underlying conditions are good. Spelter has moved a little in sympathy with lead, and seems now to be quite a strong market.

Pig Iron.

The position in the pig iron market is very uncertain. There are cogent reasons why iron should be dearer in the near future, chief amongst them being the probability of much dearer fuel. Already in the Midlands and in Lancashire fuel prices have been advanced from 1s. to 2s. per ton, and there is a promise of a further rise in order to satisfy the miners in the matter of wages next April. But while furnace coke is rising in the Midlands, in the Cleveland district prices have been easier. The large difference between Midland and Durham furnace coke is rapidly dwindling, and this suggests that the Cleveland iron district may yet be able to supply Manchester and the surrounding towns with pig iron for foundry purposes. The demand here for foundry iron is mainly confined to small lots for immediate use. Many of the larger ironfounders have evidently not consumed all that they bought at the end of last year; and it is generally believed that the actual rate of consumption in Lancashire is very much smaller than the normal. The price for Derbyshire No. 3 pig iron is still quoted here at 102s. 6d. per ton delivered, and Lincolnshire is offered at 104s. For Scotch No. 3 pig lower prices are being taken, owing to the fall in prices which is said to be connected with cheap continental material. About 116s. to 117s. 6d. is now the price here for Scotch, and as this is only about 12s. 6d. above common iron the relationship is getting more reasonable. It seems possible that rather larger quantities of Scotch iron will now be employed in this district. Not so long ago the difference was 20s. per ton.

Steel.

The markets for manufactured steel are dull and depressed, and business here is restricted to small lots. Selling agents for the steel works are hampered by the Association price. One does not hear that there has been any disloyalty, but the strain is rather severe now that merchants are quoting lower prices, and there is plenty of foreign steel offering at tempting rates. The nominal price for sections is still based on £10 in Manchester, and £10 5s. in the Cheshire towns of the neighbourhood for heavy joists and sections. Foreign steel can be bought at about £2 10s. per ton less money.

Scrap.

There is a fair demand now for heavy wrought scrap iron at £5 per ton delivered to the Lancashire forges. Apparently, in the Scotch and Yorkshire districts users of heavy wrought scrap have to pay 10s. more, so that dealers here are not satisfied that they are getting a fair price from the Lancashire iron manufacturers. For steel scrap there is still only a poor demand, but so far Sheffield remains the best market for the Manchester dealer. About 85s. on trucks in Lancashire is as much as is offered now. Cast scrap varies a good deal. If a founder wants a lot of good textile machinery scrap it might cost him 92s. 6d. or even 95s., but there are parcels of good machinery scrap on offer at under 90s.

Activity in the Locomotive Industry.

As I have previously reported in this column the locomotive building industry in Lancashire is in a more prosperous condition at the present time than it has been for a considerable period. One of the firms to benefit by the trade revival is the Vulcan Foundry, Limited, Newton-le-Willows. This company has just completed an order for fifty-five goods engines and tenders of the 2–8–0 and 6 type for the I.S.R. North-Western Railway, and ten engines for the Bombay, Baroda and Central India Railway, and has work on hand which will keep the firm's plant fully occupied for several months. During a recent visit to these works Mr. Whalley was good enough to show me the latest extensions that have been made to the shops, including a new grinding shop, which is to be equipped with a modern plant, and a shop which is to be utilised exclusively for the complete production of locomotive cylinders. The building construction adopted throughout these extensions conforms with that of the remainder of the works, a special feature being the excellence of the natural lighting. The busiest section of the works is that devoted to boiler making. Here I noted, amongst others, fifty boilers for G.2 class engines for the London and North-Western section of the London, Midland and Scottish Railway, and twenty No. 10 standard boilers for Great Western locomotives. In addition to these orders there are now in process of construction twenty engines and tenders of the 2–8–0 and 6 class for the Bengal Nagpur Railway, and twenty tank locomotives of the 0–6–0 class for the Midland Section of the London, Midland and Scottish Railway. At the time of my visit the number of hands employed was over 1300, and this number would have been much larger had it not been that certain departments were being temporarily held up by an insufficient supply of steel castings.

BARROW-IN-FURNESS.

Hematite.

There is no change in the state of the hematite pig iron trade, and some are inclined at the moment to take rather a pessimistic view. This is perhaps unwise, for shipbuilders and engineers are about to enter, or have already entered, on a period of greater activity. It is felt that the demand will improve, but the signs at present are not very convincing. For instance, a furnace which was damped down at Ulverston through the railway strike still remains idle, and this fact in itself suggests that the market is far from brisk despite the limited output. There seems to be a feeling of uncertainty abroad, and customers are still confining their orders to immediate requirements. There is some sign of fuel becoming cheaper, and this movement will have its effect on the cost of production, but a fall in pig iron prices to any appreciable extent is hardly to be looked for. There is little going to the Continent, and it may be that less will go in the future; yet, on the other hand, if the Continent capture the steel orders the requirements may be greater. Business with America is dull, and only small parcels are being shipped. The Midlands are taking the larger proportion at present.

Iron Ore.

The iron ore trade merely reflects the quietness in the iron trade, and the amount of ore raised is very limited. There is no pronounced demand for deliveries outside this district and very little is going away. The business being done in foreign ores is small.

Steel.

Orders are held which will keep the rail mills going, but the talk of continental makers securing orders is unsettling, and if the competition becomes keener this district will suffer. Belgian manufacturers are able to use steel in construction which is 30 per cent. cheaper than in this country. Foundries are fairly well employed, and there is a moderate prospect of more orders. British railways are receiving deliveries of chairs. The hoop and section mills are fairly well situated for orders.

SHEFFIELD.

(From our own Correspondent.)

Sheffield's Burden.

THE authorities in Sheffield continue to make strenuous efforts to impress upon the Government the unfortunate position in which the city is placed by reason of the drain of long-continued unemployment, and its urgent need of special assistance. Representatives of Sheffield took part in the deputation from "hard-hit areas" which waited upon Mr. Clynes, the Lord Privy Seal, last week, and the city's spokesman put the case very strongly, pointing out that the unemployed and their dependents made up 15 per cent. of the population, that Sheffield had raised out of rates £1,857,000 in respect of unemployment, and had borrowed or raised on loan nearly £2,500,000 for the same object. Mr. Clynes, in reply, was sympathetic, remarking that Ministers were working very earnestly at the question, which had ceased to be one of party, or merely a working-class question, but was one for every class in the community. He refrained, however, from making any definite statement, leaving that for the Prime Minister to do in the House of Commons. In addition to taking action generally on the question of unemployment, Sheffield is making special efforts in connection with the cruiser-building programme. The Chamber of Commerce has sent to the Prime Minister and other members of the Government, as well as to the local Members of Parliament, a strong resolution expressing the hope that the rumours of a withholding of the orders for the minimum of eight vessels are incorrect. The resolution pointed out that if these orders are not proceeded with, the result will be a very serious set-back to the expectations and efforts of Sheffield and other places, which were looking to the Navy programme for largely reducing the number of unemployed in their midst.

State of the Steel Trade.

Should the representations referred to prove effective, the Sheffield steel trade will benefit substantially, beginning with the heavy side. At present that side is not improving, but rather the reverse. The basic open-hearth furnaces are not as well employed as they were before the railway strike. This may be partly due to the dislocation caused by that trouble, but is probably to be traced in larger degree to the effects of revived competition from the Continent. Belgium and France have recently been sending into this country large quantities of basic billets, bars and sections at prices 30s. to 40s. below those of home-produced material. There has now been some easing off of this competition, and a little improvement in the outlook, but, owing to lack of orders at the moment and to some over-production, a number of furnaces which were stopped during the strike have not resumed operations. In the case of acid open-hearth steel the position is better. A large tonnage of this material is called for by the requirements of the railway departments. Prices are firm, and the state of this trade is better than for several years past. It is only in pig iron, billets and the cheaper grades of steel generally that the Sheffield trades are not expanding.

The Lighter Branches.

The makers of tools and various kinds of steel material are benefiting from the railway orders which have been placed here and in other parts of the country. The improvement in engineering and shipbuilding is also having a favourable effect locally. Numerous orders have recently been given out for machine tools, and although these are not made in Sheffield, their construction and operation call for Sheffield steel, files, twist drills and other tools. The foundry section, both steel and iron throughout the country, is also calling for more Sheffield products, and the foundries in the city itself which manufacture steel castings are doing an improved business. Makers of tools used by joiners, bricklayers and others engaged in the building trade are already busy, and are anticipating more work in view of the Government's intention to speed up house building. Production is limited to some extent by the fact that there is not much additional skilled labour available. An active seasonal demand is being experienced for farm and garden tools, and there is a prospect of last year's sales being exceeded. There has been a great reduction in the importation of tools and cutlery from Germany, and inquiries are coming to Sheffield from several overseas buyers who have hitherto given their custom exclusively to the Germans.

Cutlery and Plate.

These trades remain in much the same position as was reported last week. There is a good demand for stainless knives, though it is below high-water mark, and other branches are only doing moderately well. The trade in the cheaper classes of plated and unplated goods, particularly spoons and forks, keeps up very well, but for the better qualities of hollow-ware, as well as for sterling silver, the demand is slow. The dispute in the cutlery trade continues, and several hundred grinders are still out of work. Draft grinding regulations have just been issued by the Home Office, one part of which applies to the cutlery and edge tool industries, and the other to miscellaneous trades. Some of the new provisions are described as "drastic," and cutlery manufacturers view them with apprehension, feeling that if they are brought into operation they will do serious damage to the trades. One clause, for example, states that the height of the grinding "hull" must be at least 10ft., and the total window area at least one-sixth of the floor area. It is declared that there are at present dozens of little shops in the city which it would be impossible to alter to suit this requirement, and that, if the regulation is enforced, many of these shops will have to be closed.

A Good Order.

Although Sheffield shares in the general regret that the Indian Government has placed an order for locomotives with Germany, it has the satisfaction of knowing that Chili has not adopted that course. The Yorkshire Engine Company, Limited, Wincobank, is at work on six large engines for the Chilian Nitrate Railways. For a year or two orders for this class of locomotive went to America, but on the present occasion the Sheffield firm has been selected. The engines are exceptionally powerful, and will be used for hauling heavy trains up gradients as steep as 1 in 20. Each engine weighs 83 tons light and 110 tons in full working order. The cylinders are 22in. in diameter with a 26in. stroke. The wheels are 3ft. 6in. diameter, and the boiler is 5ft. 9in. diameter by 16ft. long between the two plates. The engines are fitted with Westinghouse brakes and electric headlights.

Pit Safety Tests.

The recent lamentable accident at the Nunnery Colliery, Sheffield, when a haulage rope broke, a train of tubs ran away, and seven men were killed, has led to experiments with a view to preventing such disasters in the future. Two appliances have been tried. One, which is not patented, but is the result of suggestions made by the officials and men, requires to be operated by human means. It consists essentially of five specially built tubs with tight couplings and special sprags to absorb a shock. The first tub contains half a ton of scrap metal, the next three are empty, and in the fifth rides a brakesman. Should the latter form the opinion that the train is out of control or running away, he pulls a lever, releasing a sprag which digs into the roadway and acts as an effective brake. The other device, which was constructed and patented by the Worsley Mesnes Ironworks, Limited, Wigan, is entirely mechanical. It also has five empty tubs, and when the train reaches a dangerous speed, the machinery automatically releases the brakes, which take the form of sprags that dig into the roadway and the roof. It is not yet decided which of the two devices will be adopted at the pit.

Gas and Electricity.

Derby Town Council has decided to apply for a loan of £90,000 in order to extend the generating plant at the electricity station. It was stated at the Council meeting that the proposed expenditure would not make any call on the rates. Derby was one of the five large stations to be retained in the East Midlands area, and was destined to play an important part in that area. It was estimated that by 1926 the sale of electricity would have increased to 30 million kilowatts, as compared with 23 millions to-day. At Scarborough, the gas company has reduced its price from 3s. 6d. to 3s. 3d., which, with the discount allowance, is equivalent to 3s. per 1000 cubic feet. A new scheme of lighting is to be put in force next season, and it is claimed that the town will then be the best lighted in the kingdom. The lighting on the foreshore will be greater than that in Whitehall, London.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Position.

THE continued threat of industrial warfare constitutes the chief obstacle in the path of trade expansion, and caution is still the guiding principle on the part of all concerned in the commercial world. At the beginning of the year industrial prospects were showing considerable improvement, but the labour upheavals during the past two or three weeks have caused a serious set-back, and the outlook at the moment is very discouraging. A good deal of apprehension prevails in regard to the prospects of a dockers' strike. Should it develop it would, of course, stop the inflow of cheap foreign iron and steel which has so disturbed the British market; but by checking local exports of both iron and steel it would have a serious effect upon local industry. Moreover, deliveries of foreign material are already so uncertain that British consumers are disinclined to treat for further supplies. On the whole, therefore, to this district the prime interest is peace, and it is hoped that an amicable settlement will be reached.

Cleveland Iron Trade.

Conditions in the Cleveland pig iron trade have undergone little change during the week. There is, perhaps, a little more inquiry for iron, some of the works being unable to hold off any longer; but the demand still falls far short of the output, and makers' stocks tend to increase. One blast-furnace, which has been engaged on the production of Cleveland iron, has been put out of operation, and another has been transferred to ferro-manganese. The distribution of the 48 blast-furnaces operating on the North-East Coast is now as follows:—Cleveland, 14; hematite, 16; basic and other kinds of iron, 18. The reduction in the number of Cleveland furnaces somewhat adjusts the balance, but even yet production is not fully absorbed, and prices are weakening. No. 3 G.M.B. Cleveland pig iron is now down to 97s. 6d. per ton, and although No. 1 is still quoted at 100s., it might be purchased at less. No. 4 foundry is 95s. 6d., and No. 4 forge 94s. 6d.

Hematite Pig Iron.

The big contracts booked by East Coast hematite pig iron makers some time ago are enabling them to keep going, but their surplus output is not easily marketed. However, in this branch of the industry there is not such keen competition, and mixed numbers remain steady at 101s. 6d., and No. 1 at 102s. 6d. per ton, although possibly a firm offer of business at a lower figure would not be refused.

Iron-making Materials.

The industrial outlook is too obscure for any forward buying of foreign ore, and consumers are content to take deliveries under contract. Freights are still very high, but best Rubio ore remains nominally at 24s. per ton c.i.f. Tees. A drop in coke prices has afforded welcome relief to the ironmasters. Good medium furnace kinds are now about 34s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

Despite the recent lull in buying, the steel works are not badly placed for orders, but specifications are, in many cases, slow in coming to hand, and manufacturers would welcome a little more freedom. There is still keen competition for export orders and some under-

cutting of prices, but the price agreement in the home market still holds good.

Shipbuilding.

Greater activity is noticeable in the shipbuilding trade on the North-East Coast, and it is reported that a fair number of inquiries for new tonnage are circulating. This week the Smith Dock Company has booked an order for a steamer of 3450 tons deadweight for Newcastle owners The vessel will be built at the firm's South Bank Yard, and will be suitable for either coasting or Baltic trades.

The Coal Trade.

The Northern coal trade has assumed a very healthy appearance, and there does not seem to be a single weak spot in the market. The home household demand is at its maximum, the demand for industrial purposes is steadily increasing, and the export position is remarkably strong for this season of the year. Sellers for this month's delivery are hard to deal with, and they hold for firm prices. The general tendency of the market, in fact, continues in sellers' favour, as there is a pronounced scarcity of many favourite grades, and the fear of a transport stoppage leads consumers to take every precaution to get in as large stocks as possible. Hope continues that the trouble with the dockers will be amicably settled, but all are taking precautionary measures. For next month and April there is a steady inquiry, and among new business on offer are inquiries for steams from the United States and also South America. The interference with the output occasioned by the recent railway strike is still a contributory factor to the prevailing scarcity of fuel, and it is expected, at any rate for the next month or two, that the tendency will be towards higher prices all round. In fact, there is every indication that the surplus for export will be seriously curtailed and inadequate to meet demands from abroad. The pressure for Northumberland steam coals is particularly strong, and shipments during the next few weeks are likely to be on a heavy scale. Boom conditions prevail in the Durham gas coal section. There is an exceptionally brisk demand for all descriptions, both on home and export account, and loading turns for the latter direction are now almost impossible to arrange for the next few weeks. A similar position has also developed in regard to Durham bunkers, and the coaling stations, in particular, are calling for heavy supplies. There is little movement in the coke trade. Patent oven cokes are in slow demand for inland consumption, and quiet for export. Stocks are plentiful, and prices show a weak tendency.

SCOTLAND.

(From our own Correspondent.)

Revival Delayed.

THE anticipated revival in trade suffers still further delay in view of possible labour disputes in the near future. A dockers' strike is almost upon us, uncertainty exists in the coal trade, and now there is announced an application for an advance in wages of all shipyard workers. It would thus appear as though a period of industrial peace of sufficient duration to secure a trade revival is as far off as ever. Dispute follows dispute with distressing regularity, and a feeling of security is impossible. The shipbuilding industry on the Clyde has improved considerably and gives promise of still better things to follow, but another wages dispute would only undo all the good work. Steel and iron works have not yet benefited to any extent from the increased shipyard activities, but orders are beginning to filter through, and it will be a severe blow if their expectations in this direction are blighted even for a time.

Continental Competition.

Competition from continental producers is becoming keener, and even although local consumers are perhaps not taking much advantage of the keen prices offered for materials, the effect is apparent in their dissatisfaction with the rates quoted by home works and their determination to curtail buying to the lowest possible limits. The drop in foreign inquiries may probably be attributed to the same circumstance. On the other hand, it is stated that some purchasers of foreign material have experienced difficulty in securing deliveries, and that may deter others from entering into contracts abroad.

Dull Pig Iron Market.

The competition already referred to is said to have considerably affected the pig iron and scrap trades. At any rate, the first named now shows little fresh movement, and while prices are apparently maintained, a weaker tone is evident, and cheaper terms can be arranged for a good order. Scrap material is dull in the extreme at present.

Finished Steel and Iron.

The position of steel makers has altered very little, if at all. Specifications for plates and sections are far from plentiful, and though great hopes are centred on the recent improvement in the shipbuilding industry and structural engineering, the labour outlook is not encouraging. Home prices are unchanged, but export quotations are much easier. Steel sheets are comparatively active again, but are far from regaining their activity of a month or two ago. The bar iron works are fairly well employed at present, but very little fresh business is coming forward to replace orders completed. Present contracts, however, may last until conditions are somewhat better. The re-rolled steel department of the bar iron trade is the weakest feature meantime. Prices have receded somewhat already, but a lower level may have to be touched before business will be forthcoming to any extent. Competitive prices are still a shade keener than those quoted for the local material.

Coal.

Conditions in the Scotch coal trade are again more normal. The collieries have still some arrears to overtake as a result of the railway strike, but deliveries to the docks are being made with greater regularity, and shipments are fairly prompt except at Methil, where large numbers of steamers have been held up. Forward inquiries are comparatively good, but the existing level of prices is a great deterrent to business. Buyers are not prepared to pay so highly for future requirements, while owners, in view of eventualities, are not over-anxious to commit themselves, and are preserving a firm attitude. Aggregate shipments for the week amounted to 283,255 tons, against 228,396 in the preceding week, and 302,132 tons in the same week last year. Foreign cargoes from Methil were an unusually large total, amounting to over 70,000 tons in all. The home market is active. Industrial demands continue to grow, and household fuel has a very ready sale.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

REFERENCE was made last week to the uncertainty regarding the outlook for the coal trade, and unfortunately this uncertainty has since then become more accentuated. The trend of the coal and freight markets has gone very much on the lines indicated, as not only are coals firmer, but freights have shown a marked advance, particularly for the Mediterranean, much to the discomfiture of merchants with c.i.f. obligations contracted for a fortnight or more ago. It was foreseen that, rates of freight being comparatively low, the tendency to any change would be in an upward direction, and it was thought that perhaps values would improve to the extent of 9d. to 1s. for West Italian ports. It is, however, very questionable whether anyone believed that rates would advance so quickly as they have done, inasmuch as the current rate for tonnage of 5000 to 6500 tons is now 11s. 6d., as against about 9s. ruling when the strike on the railways came to an end. The scarcity of tonnage is most pronounced, and is brought about by the fact that many owners have been attracted by the high homeward rates obtainable from the Plate, and have, as a consequence, sent their steamers out in ballast. Their action in this respect has also been very largely dictated by the fears that a strike of dockers in this country would be detrimental to their interests as they ran the risk of having their tonnage held up in port. The result has been that a good deal of tonnage has been diverted from this country. It is significant of the difficulty of merchants to get owners to load their steamers outward for the Plate, on account of the possible delays, that they have had to bid up for tonnage, and rates from Bristol Channel to the Plate have advanced from about 12s. 6d. to 15s. It is also undeniable that tonnage is now more spread over the globe than has been the case for several years past, so that the tonnage on offer on this market at the present time is very limited, and quite below the requirements of charterers. Undoubtedly, many merchants have been badly hit by the sharp movement upwards in freights, and the position is much the same for the firms which have sold coals and have not covered themselves with the collieries, as prices of best Admiralty large are round about 30s. to 31s., and collieries have practically none to offer for the remainder of this month, while so far as March shipment is concerned, they are quoting as much as 32s. The demand from abroad has not materially expanded, except that the foreign coaling depôts are none too well off for supplies, and consequently efforts are being made to expedite shipments, so that their stocks may be replenished. Merchants hold a considerable number of orders for Italy, which have to be executed this month or the early part of next, and the probability is that as time wears on and the crisis regarding the demands of the miners for a new wage agreement and the expiration of the existing agreement is reached, a better inquiry will be seen for coals. In these circumstances, a fall in coal prices is not looked for, while it is quite on the cards that freight rates will go even higher than they are at present. Since writing last week, news has been received respecting the tendering for the Egyptian State Railways' order for 200,000 tons of Monmouthshire or Cardiff large steam coals for shipment, from March to July inclusive, to Alexandria. It is reported on very good authority that the prices submitted range from 30s. 10d. to over 39s. net c.i.f. Alexandria, though in one case at least a price was offered of supplies on a f.o.b. basis. So far as is known, the order has not yet been allocated, but on the basis of the current rate of freight for Alexandria the business leaves very little more than 25s. for the coals, in the case of the lowest tender put in, which is a very low figure. Since the tenders were submitted, the rate of freight for Alexandria has improved, as it is now about 11s. to 11s. 6d., as against 10s. to 10s. 6d. in the early days of this month. One inquiry which is now on the market is that of the Norte Railways of Spain for 20,000 tons of Admiralty or Monmouthshire large coals for shipment during March and April.

LATER.

The latest information concerning the Egyptian State Railways' order is contrary to expectations, and that the railways have only purchased 50,000 tons of Monmouthshire large at 26s. 3d. f.o.b. It is their intention to ask for fresh tenders in a month's time for the balance of their requirements, viz., 150,000 tons.

Dock Charges.

The South Wales General Committee, representing traders, met this week to give consideration to the communication from the Great Western Railway Company on the subject of the figures which had been submitted by the Committee to the company at the interview on January 11th respecting the claim for a reduction in dock charges. The General Committee has decided that it is unable to accept the explanations made, and will revert to them at the next quarterly meeting. Having regard to the present circumstances, the Committee is deferring until March next its application for a further reduction in dock charges, but it will at the quarterly meeting to be held in March strongly press that concessions should be given as from April 1st.

Ship-repairing Competition.

An instance of the difficulties which ship repairers in this district have to contend with has come to light during the past week. The Norwegian steamer Nico, of 679 tons net register, recently ran aground outside Swansea, and sustained extensive bottom damage. The steamer was consequently placed in the Albion Dry Dock at Swansea for inspection, when it was found that about sixty bottom plates would have to be attended to, as well as floors, frames, &c., to place her in a seaworthy condition. The usual specifications were submitted to firms, which were asked to tender for the job. Altogether, nine firms tendered. Of them seven were in the Bristol Channel and the other two were at Rotterdam; and, unfortunately for employment in this district, both the tenders of the Rotterdam firms were below those of local undertakings, while, in addition, the time in which they undertook to complete the work was shorter. The tenders of local firms ranged from £7490 down to £5287, the period in which the work was to be done in the case of the lowest tender being fifty-five working days. The Wilton Engineering and Slipway Company, of Rotterdam, however, secured the order with a tender of £4500, with the work to be carried out in thirty-four days, the price including the cost of towing the ss. Nico to Rotterdam and bringing her back to Swansea, which is estimated at about £200. No doubt, it will be wondered by many how the Dutch firm can cut in in this way, but the explanation which has been forthcoming is that Dutch firms are subsidised to the extent of 30 per cent. on the price they quote for the order by the Dutch State and the municipality obtaining the work, so that their workmen shall be kept employed. If this is the case, then the firm which put in the lowest price will be paid the tender price of £4500 plus the sum of £1350, thus making the total amount £5850, which in reality is £563 higher than the lowest price tendered by a Bristol Channel firm. Such foreign competition can only be described as inequitable.

Current Business.

Steam coals of all descriptions are very steady, and the loading pressure at all ports is very heavy. The arrivals of tonnage over last week-end were numerous, and early this week the number of steamers waiting for berths was about ninety. Naturally the owners of many of these boats are very anxious to get them loaded and sailed this week, on account of the fear that a strike on the part of dockers on Monday may result in the detention of tonnage. The majority of collieries have such heavy commitments that they have no coal to spare for this month's shipment, and prices, particularly in the case of the superior qualities, are little more than nominal, while for next month colliery salesmen are very optimistic that prices will appreciably improve, and are asking for 32s. for best Admiralty large coals. Small coals are also firm, and superior steam qualities are commanding 22s. to 23s. Coke is not quite so strong a market, but patent fuel is well maintained, while pitwood is none too plentiful, and is steady. Anthracite coals, more especially sized descriptions, are firmer on account of the better inquiry inland.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. WALLIS BAINBRIDGE informs us that Paul Wurth, Limited, of Luxembourg, have appointed him their British agent.

WE are informed by Kasenit, Limited, 8 and 9, Ludgate-square, that they have now taken over the world's rights and sole manufacture of "Anti-cementite."

THE STAVELEY COAL AND IRON COMPANY, Limited, near Chesterfield, informs us that Mr. T. A. McKenna has been appointed its London representative, and that he will be in charge of its London office at 34, Victoria-street, Westminster, from the 1st prox.

MR. GEORGE RICHWOOD, who was at one time sales manager of the machinery department of Millars' Timber and Trading Company, Limited, and more recently manager of the machinery department of Gaston, Limited, has now been appointed sales manager for the construction machinery department of John Fowler and Co. (Leeds), Limited.

CONTRACTS.

LOUDON BROTHERS, Limited, of Glasgow and Johnston, have just secured important contracts for heavy workshop plant from the Portuguese Government Railway Administration, Colonial Governments and home railways.

WE are informed that the order for the first four hydraulic coal hoists to be put down in connection with the extension schemes promoted by the Great Western Railway Company for the Cardiff docks, has been placed with the Hydraulic Engineering Company, Limited, Chester. These hoists will be designed for dealing with 30-ton loads, and are to be erected at the East Bute Dock.

THE Union d'Electricité, which has power stations at Gennevilliers and Vitry, near Paris, has placed a large order for pulverised fuel plant with the company associated with Vickers and International Combustion Engineering, Limited, of London. It is for the power station at Gennevilliers, for the new extension of which Ladd-Belleville boilers with Lopulco plant for pulverised fuel firing have been chosen. This contract is, in a sense, a repeat order, because similar plant is already in hand for the power station at Vitry, owned by the same power company. One of the companies associated with Vickers and International Combustion Engineering, Limited, has also received a contract to equip the new power plant of the Société Metallurgique de Hoboken, near Antwerp, with boilers arranged to use pulverised coal and Lopulco equipment.

FRENCH AND ITALIAN SUBMARINES.—Referring to a "Journal" note under the title given above in our issue of January 25th, Messrs. Sulzer Brothers ask us to state that it was incorrect to say that the majority of the submarines to be built for the French Government will be fitted with Schneider-Carels Diesel engines, for an equal number will be fitted with Sulzer engines.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	19/6 to 20/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	24/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 8 9	—
No. 1 Foundry	5 10 0	—
No. 3 Foundry	5 2 6	—
N.E. COAST—		
Hematite Mixed Nos.	5 1 6	5 1 6
No. 1	5 2 6	5 2 6
Cleveland—		
No. 1	5 0 0	5 0 0
Silicious Iron	5 0 0	5 0 0
No. 3 G.M.B.	4 17 6	4 17 6
No. 4 Foundry	4 15 6	4 15 6
No. 4 Forge	4 14 6	4 14 6
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	9 2 6	—
North Staffs. Forge	4 10 0 to 4 12 0	
,, ,, Foundry	4 17 6	—
(3) Northampton—		
Foundry No. 3	4 13 6 to 4 15 0	
,, Forge	4 7 6	—
(3) Derbyshire—		
No. 3 Foundry	4 15 0 to 4 16 0	
Forge	4 8 0 to 4 10 0	
(3) Lincolnshire—		
No. 3 Foundry	4 15 6	—
No. 4 Forge	4 14 0	—
Basic	4 15 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	{5 15 0 (a) / 6 0 0 (b)}	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 10 0	—
Best ,,	—	—
N.E. COAST—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 15 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 10 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 10 0 to 12 15 0	
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	11 10 0	—
Gas Tube Strip	12 17 6 to 13 0 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 10 0	—
Ship Plates, ¾in. and up	10 5 0	—
Sections	10 0 0	—
Steel Sheets, 5/16in. to ¾in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	19 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	10 5 0	—
Angles	10 0 0	—
Boiler Plates	13 10 0	—
Joists	10 0 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0	—
Channels	9 5 0	—
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 5 0†	—
Light ,,	9 10 0 to 10 0 0†	
Billets	8 10 0 to 12 0 0†	
Hoops	14 10 0	—
MANCHESTER—		
Bars (Round)	10 10 0 to 10 15 0	
,, (others)	10 5 0 to 10 7 6	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	10 10 0	—
,, (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	8 15 0	—
Hoops	12 10 0 to 13 0 0	
Soft Wire Rods	11 10 0	—
MIDLANDS—		
Small Rolled Bars	10 15 0 to 11 0 0	
Billets and Sheet-bars	8 0 0 to 8 5 0	
Gas Tube Strip	10 15 0 to 11 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	18 5 0 to 18 10 0	
Angles	10 0 0	—
Joists	10 0 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	23/9 to 24/3
Block Tin (cash)	268 5 0
,, (three months)	266 0 0
Copper (cash)	62 12 6
,, (three months)	63 10 0
Spanish Lead (cash)	34 0 0
,, (three months)	32 15 0
Spelter (cash)	36 5 0
,, (three months)	35 2 6
MANCHESTER—	
Copper, Best Selected Ingots	66 15 0
,, Electrolytic	67 10 0
,, Strong Sheets	95 0 0
,, Tubes (Basis price)	0 1 1
Brass Tubes (Basis price)	0 1 0
,, Condenser	0 1 2¼
Lead, English	35 5 0
,, Foreign	34 5 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	10/6
,, 6 p.c. to 8 p.c. ,,	£22 10 0	8/-
,, 8 p.c. to 10 p.c. ,,	£22 0 0	8/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£45 0 0	18/-
,, ,, 1 p.c. ,,	£56 0 0	21/-
,, ,, 0.75 p.c. carbon	£68 0 0	22/6
,, carbon free	1/6 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£17 for home, £17 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 5 0	scale 5/- per unit
,, ,, 75 p.c.	£18 10 0	scale 6/- per unit
,, Vanadium	20/- per lb.	
,, Molybdenum	8/6 per lb.	
,, Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£130	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	25/6
,, ,, Ell	26/6
,, ,, Splint	27/6 to 28/6
,, ,, Trebles	27/-
,, ,, Doubles	25/-
,, ,, Singles	22/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	25/6
,, ,, Splint	26/6
,, ,, Trebles	27/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	22/6 to 25/-
Screened Navigation	29/-
Trebles	27/6
Doubles	24/6
Singles	22/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	25/-
Secondary Steam	23/-
Trebles	27/-
Doubles	26/-
Singles	22/6

ENGLAND.

(8) N.W. COAST—	
Steams	29/-
Household	49/- to 59/-
Coke	40/-
NORTHUMBERLAND—	
Best Steams	25/6 to 26/-
Second Steams	24/- to 25/-
Steam Smalls	15/-
Unscreened	22/- to 23/-
Household	27/6 to 32/6
DURHAM—	
Best Gas	25/-
Second	24/6
Household	27/6 to 32/6
Foundry Coke	33/-

SHEFFIELD—	Inland.	Export.
Best Hand-picked Branch	35/- to 36/-	—
Barnsley Best Silkstone	30/6 to 32/-	—
Derbyshire Best Brights	30/- to 32/-	—
,, ,, House	26/- to 27/-	—
,, ,, Large Nuts	24/6 to 25/6	—
,, ,, Small ,,	18/6 to 20/6	—
Yorkshire Hards	25/- to 27/-	—
Derbyshire ,,	24/- to 25/-	—
Rough Slacks	12/6 to 13/6	—
Nutty ,,	10/- to 12/-	—
Smalls	7/- to 9/-	—
Blast-furnace Coke (Inland)	27/- to 29/-	
,, ,, (Export)	f.o.b.	35/- to 36/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	30/6 to 31/6
Second ,, ,,	29/- to 30/-
Best Dry Large	29/- to 30/-
Ordinary Dry Large	27/- to 28/-
Best Black Vein Large	28/6 to 29/6
Western Valley ,,	28/- to 29/-
Best Eastern Valley Large	27/6 to 28/6
Ordinary ,, ,,	26/- to 27/-
Best Steam Smalls	22/- to 23/-
Ordinary ,,	20/- to 22/-
Washed Nuts	28/- to 30/-
No. 3 Rhondda Large	30/- to 31/-
,, ,, Smalls	25/- to 26/-
No. 2 ,, Large	24/- to 25/-
,, ,, Through	21/- to 23/-
,, ,, Smalls	19/- to 20/-
Coke (export)	52/6 to 57/6
Patent Fuel	30/- to 32/6
Pitwood (ex ship)	33/- to 33/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	40/- to 42/6
Seconds	32/6 to 35/-
Red Vein	30/- to 31/-
Machine-made Cobbles	50/- to 55/-
Nuts	50/- to 55/-
Beans	46/- to 47/6
Peas	26/- to 27/-
Breaker Duff	12/9 to 13/-
Rubbly Culm	14/- to 14/6
Steam Coals:	
Large	24/6 to 25/-
Seconds	22/- to 23/-
Smalls	14/- to 16/-
Cargo Through	19/- to 21/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

† Latest quotations available. (a) Delivered Sheffield or Glasgow, (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Prohibiting Imports.

THE Government has obtained powers from the Chamber of Deputies to carry out reforms and introduce such measures as may be necessary to stabilise the franc by means of decrees; that is to say, the Cabinet will be able to decide upon financial restrictions and immediately enforce them without the sanction of Parliament, although the Chamber will have the right, at any time, to discuss the expediency of those measures and to reverse them if it be found desirable to do so. One of the proposed restrictions is to prohibit the importation of goods which are not necessary to the "country's security," the idea being to strengthen the financial position by preventing an unnecessary expenditure on foreign products. It is obviously difficult to fix upon the goods which should come within this category. The Government has, therefore, obtained powers to prohibit the importation of products and merchandise by decree, which means that it would be invested with the same powers as during the war, when the importation of any goods could be prohibited without notice, if it were considered necessary in the country's interest. Such autocratic powers are strongly opposed by the commercial community, which is fully aware of the disastrous consequences that might follow upon an arbitrary interference with the course of trade. A measure that may be justified in time of war would have wholly different consequences in time of peace, and foreign trade could certainly not resist the perils that would surround it if the Government were empowered to hold up goods at any moment it pleased. Moreover, the prohibition of one class of goods, because it happens that they are not particularly needed, may react on home industries in unexpected ways. In order, for example, to bring down the expenditure on foreign grain the exportation of flour was prohibited, but as the millers at Marseilles depend upon the temporary free importation of grain to be reduced to flour for export, the effect of the measure was to shut down some of the mills, and the ships which brought the grain to the mills and left with flour are deprived of freights. The economical situation is bound up with so many varying interests that it is impossible to adopt arbitrary measures in favour of some without seriously affecting others. What may happen in the future, if a policy of restriction should have the effect of closing foreign markets, is seen in the facilities being offered to encourage the exportation of iron and steel products, whereby a reduction is accorded in the price of coke in proportion to the quantity of iron and steel sent away, as well as in the concessions to shipbuilders and others to enable them to secure foreign business.

Agricultural Machinery.

Another example of the vagaries resulting from the proposed new fiscal policy is seen in the Bill which has been introduced into the Chamber of Deputies authorising the Government to suppress temporarily the import duties on agricultural machinery. The farming industry is protected by an import duty on grain, and as the home production last year was much below what had been anticipated, much larger quantities of wheat had to be imported to make up for the deficit, and as the cost of this grain, burdened by the duty, would have appreciably increased the cost of living at a time when it was necessary to bring it down and help the franc, the Government reduced the import duty. At the same time, the cheapening of imported grain deprived farmers of some of the profit that they had reasonably hoped to secure from their highly protected industry. Therefore, the Government was obliged to offer them some compensation in the form of cheaper machinery. In view of the labour scarcity much more machinery must be employed if the country is to supply anything like it maximum quantity of grain, and as the home agricultural engineering industry cannot meet the requirements the Minister of Agriculture finds that there is no alternative but to admit foreign machines free of duty. This is being done at a time when the French agricultural engineering industry is clamouring for further protection on the ground of higher manufacturing costs. The Government, therefore, proposes to sacrifice resolutely the interests of French agricultural engineers to the interests of farmers, who need cheaper machinery, and there is no doubt that the suppression of the import duties will do something to facilitate the purchase of British machines by French farmers. At the same time, the efforts of the Government to secure arbitrary powers for dealing with the commercial and industrial situation, so far as concerns imports and exports, will certainly meet with considerable opposition. It is doubtful whether the franc can be improved by any artificial means. Prohibition of imports and exports, or super-tax on import duties and even a suppression of duties in isolated cases, will not improve a situation which depends upon the conditions of internal finance and a solid basis of commercial credit.

Desert Traction.

The experience with the Citroën-Kégresse endless track vehicles a year ago, when they traversed the desert both ways between Touggourt and Timbuctoo by a circuitous route to include oases and military posts, proved that the type of endless track car could easily negotiate sandy wastes and the rocky beds of ancient rivers. Since then interesting experiments have been made with the Renault six-wheeled cars with big section low-pressure pneumatic tires, and towards the end of last month the aviation authorities ran three of these cars from Colomb-Becher, the terminus of the Oran line, to Bourem, on the Niger, by way of Adrar, Quellen and Tessalit. This straight and direct route, a distance of about 1180 miles, was covered in six days, including one day employed upon exploration work. Actually, therefore, the time taken was less than a quarter of the twenty-one days occupied on the longer route a year ago. This would appear to confirm reports to the effect that the direct route from Colomb-Becher offers no serious difficulties to motor cars. The six-wheeled Renault cars, which accomplished this performance, were propelled by 10 horse-power engines driving four wheels through two axles with the differentials coupled by a flexible joint.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

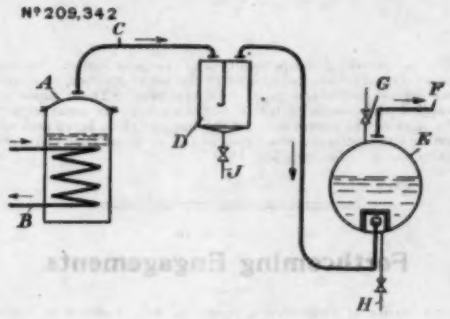
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

209,342. March 24th, 1923.—HEAT ACCUMULATORS, *E. C. R. Marks*, 57, *Lincoln's Inn-fields, London, W.C.* 2.

This invention is concerned with the utilisation of the vapour rising from evaporating pans. It is urged that the usual system of working below atmospheric pressure is open to the objection that air finds its way into the apparatus. The whole system is, consequently, worked at a pressure above that of the atmosphere. A is the evaporating pan, which is heated by the coil B. This

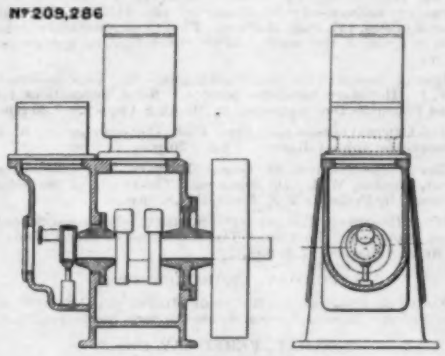


coil receives the exhaust from a back-pressure engine, working at a pressure of about 25 atmospheres and exhausting at about 15 atmospheres. The vapour from the pan A leaves by the pipe C, and after passing through a separator D is delivered into the water space of the heat accumulator E. Steam from the accumulator is taken away, at F, to a condensing engine. G is an air vent, while H and J are drains.—*January* 10*th*, 1924.

INTERNAL COMBUSTION ENGINES.

209,286. December 23rd, 1922.—AIR PUMPS FOR TWO-STROKE ENGINES, Sir K. I. Crossley and W. le P. Webb, Openshaw, Manchester.

In accordance with this invention, the scavenge pump is driven from a separate crank pin on the engine crank shaft. A bearing is fitted on each side of the motor crank, and the crank pin for driving the scavenge pump is overhung outside the bearing on the scavenge pump end of the crank shaft. The scavenge pump crank and crank pin are made separate from, but bolted securely to, the end of the motor crank shaft.

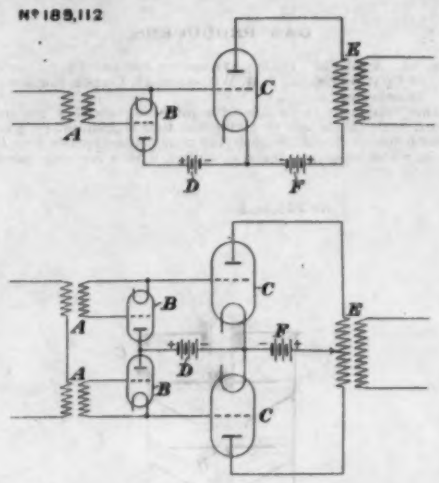


Preferably, the scavenge pump crank is in the form of an eccentric disc so as to serve for the operation of pumps for fuel, lubricating oil and water. In order to facilitate the assembly of the crank shaft and its bearings, the bearings are placed upon the crank shaft at the opposite sides of the motor crank, and the scavenge pump crank is secured upon the end of the crank shaft before the parts are placed in position within the engine housing. The crank shaft and its bearings are then threaded axially into the crank chamber and the bearings bolted to the frame of the engine housing.—*January* 10*th*, 1924.

TELEGRAPHS AND TELEPHONES.

189,112. November 7th, 1922.—IMPROVEMENTS IN VALVE AMPLIFIERS FOR ELECTRICAL OSCILLATIONS, Gesellschaft für drahtlose Telegraphie, m.b.H., of 9, Tempelhofer Ufer, Berlin, Germany.

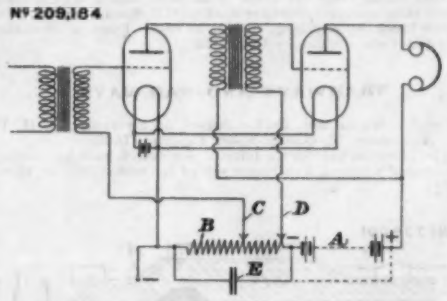
In the usual arrangement shown in the upper illustration the oscillations to be amplified are brought by means of transformer A to the grid filament circuit of a valve B, the filament of which is connected to the grid of a valve C, while its anode is connected through a source of current D to the filament of the valve C, the anode of which is connected through the primary of a transformer E and a source of current F to its filament, the secondary of the transformer E being in the output circuit. The oscillations cause variations of the potential of the grid of the valve B, resistance of which therefore varies in rhythm with the oscillations and hence the voltage supplied from source D to the grid of the valve C varies in rhythm with the oscillations. According to this invention, two main valves, such as C, are connected together back to back, the whole arrangement being shown in the lower drawing. The oscillations to be amplified are brought by means of two transformers A to the grid circuits of two valves B, having the anodes connected together, while the filament of each is connected directly to the grid of one of the valves C, having the filaments connected together. The common source D supplies the grid voltage for both the valves C. A common high-tension battery F is connected to the middle of the primary of the transformer E, the ends of this primary being connected to the anodes of the two valves C. The heating circuits



of the valves B must be insulated from the batteries D and F and from the heating circuits of the valves C.—*January* 10*th*, 1924.

209,184. October 4th, 1922.—IMPROVEMENTS IN THERMIONIC VALVE CIRCUITS, Peter William Willans, of The Cottage, Pattishall, Towcester, Northamptonshire.

According to this invention, a negative potential is applied to the grid of an amplifying valve by inserting a resistance in the anode circuit between the filament and the negative terminal of the high-tension battery, and the voltage drop along the resistance, due to the anode current, furnishes the negative voltage required. The grid is connected to any suitable point in this resistance. The resistance is shunted by a condenser of large capacity to by-pass the alternating current. Another condenser

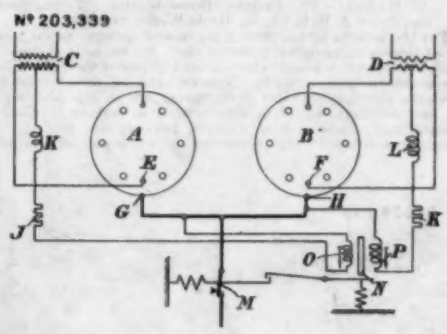


may be inserted across the filament and grid. The two valves have a common high-tension battery A, and between the negative terminal of this battery and the negative ends of the filaments of the valves, there is a resistance B, to which the grids of the valves are connected by tappings C D. By adjusting these tappings any required negative voltage can be supplied to the grids. The resistance B is shunted by a condenser E, which should be of such a capacity that its impedance for the frequency at which the amplifier works is small in comparison with that of the resistance. If preferred, the condenser may shunt the battery A as well as the resistance B.—*January* 4*th*, 1924.

TRANSFORMERS AND CONVERTERS.

203,339. August 30th, 1923.—IMPROVED SYSTEM OF ELECTRICAL CONNECTIONS FOR RECTIFIER PLANTS HAVING RECTIFIER CYLINDERS WORKING IN PARALLEL, Aktiengesellschaft, Brown, Boveri et Cie., of Baden, Switzerland.

When a number of rectifier cylinders work in parallel, it may happen, at a time during which the entire plant or the cylinders working in parallel are without load, that the excitation of one of the rectifier cylinders fails. When the load is again thrown on the plant, the rectifier cylinders, with their exciting arcs still burning, will take the whole of the load and thus become overloaded. With the object of avoiding this happening, the common switch of the cylinders working in parallel is opened by a relay when the excitation of any one cylinder fails. A and B are two rectifier cylinders working in parallel; C and D are their exciting



transformers; E and F the exciting anodes; G and H the cathodes of the rectifiers; J and K the resistances included in the exciting circuits; K and L are choking coils inserted in the exciting circuits; M is the main switch of the rectifier group in the common lead leading-out from the cathodes; N is a relay which is dependent upon the exciting currents. This relay N has two windings O and P, which are traversed by the exciting currents of the two rectifier cylinders, and are connected in such a manner that they assist each other. When both exciting currents are flowing, the relay N is sufficiently powerful to attract its armature, and thereby hold the switch M in its closed

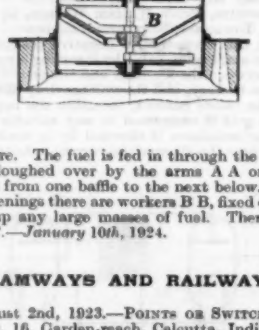
position. When only one of the two exciting currents is flowing, the relay becomes so weak that it allows its armature to be pulled off by a spring and the catch holding the main switch is opened.—*January 10th*, 1924.

GAS PRODUCERS.

209,352. April 17th, 1923.—APPARATUS FOR THE DISTILLATION OF COAL OR SHALE, T. R. Wollaston, 26, Corporation-street, Manchester.

This apparatus is intended for mounting above a gas producer, with the object of giving the fuel a preliminary treatment before it enters the gasifying zone. It comprises a casing inside which there is a series of baffles, with a rotating spindle

Nº 209,352



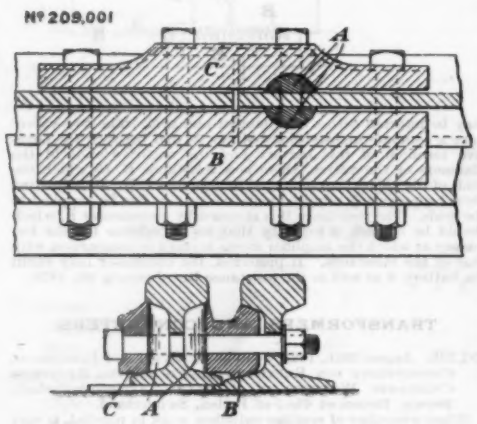
down the centre. The fuel is fed in through the hopper at the top, and is ploughed over by the arms A A on the spindle, so that it falls from one baffle to the next below. In the communicating openings there are workers B B, fixed on the spindle, which break up any large masses of fuel. There is an outlet for the gas at C.—*January 10th*, 1924.

TRAMWAYS AND RAILWAYS.

209,001. August 2nd, 1923.—POINTS OR SWITCHES, R. D. T. Alexander, 16, Garden-reach, Calcutta, India.

The inventor provides a fulcrum for switch rails by bolting arc-shaped pieces A A on either side of the web, and seats them

Nº 209,001



in recesses in the packing piece B and fish-plate C. The holes through the arc-shaped pieces are tapered to accommodate the angular movement of the rail.—*January 3rd*, 1924.

MOTOR CARS AND ROAD TRAFFIC.

209,233. October 28th, 1922.—LAMINATED SPRINGS, Sir R. A. Hadfield, 22, Carlton House-terrace, Westminster, and Major A. B. H. Clerke, Hecla Works, Sheffield.

For the correct lubrication of laminated springs, an oil with a fair degree of viscosity is better than grease, as it is sucked back between the leaves by the relative movement thereof. With the ordinary type of spring, however, the oil would tend to work out through the sides of the spring, where it is free to do so, and difficulty would be experienced in making it spread longitudinally, where it is wanted, between the leaves. A spring, according to this invention, is, consequently, formed

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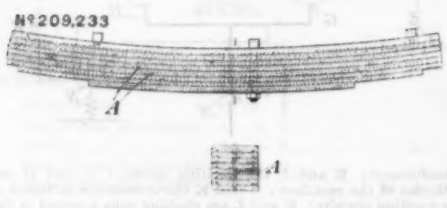

of a special section of steel, each leaf, except the master leaf, being formed towards its outer edges, with two slight upwardly extending longitudinal ribs fitting into corresponding grooves in the lower surface of the leaf above, so that the space between the two ribs forms a shallow longitudinal trough or space along which oil can spread readily under the movement of the spring, the inter-engaging ribs and grooves serving to maintain the oil in place and prevent it escaping at the sides of the spring from between the leaves. The form of the leaves is shown in the drawing, while holes for allowing the oil to pass from one leaf to another are shown at A A.—*January 10th*, 1924.

MISCELLANEOUS.

208,979. May 1st, 1923.—EXTRACTING WATER FROM PEAT, A. ten Bosch, Bachmanstraat 9, The Hague, Holland.

The inventor says that one of the chief obstacles to the draining of peat bogs to such an extent that the peat has a commercial value, is the existence of an almost impenetrable layer between the peat and the underlying strata. This layer is, he

Nº 208,979

says, produced by the percolation of the peat water. He consequently cuts drainage ditches in the usual manner, as shown, and drives perforated pipes into the peat. These pipes are supplied with steam, such as the exhaust from the main engines. The heat of the steam attacks the impenetrable layer and also destroys the colloidal condition of the peat, so that the water drains away.—*January 3rd*, 1924.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

DIESEL ENGINE USERS' ASSOCIATION.—Engineers' Club, Coventry-street, W. 1. Discussion, "Heavy Oil Engine Working Costs," based on the second report of the Committee of the Association.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Albany Hotel, Forgate, Sheffield. Conjoint meeting with the Institution of British Foundrymen. 7.45 p.m.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—University College, Singleton Park, Swansea. Paper, "Fatigue and the Elastic Limit," by Professor C. H. Desch, F.R.S. 7.15 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, London, S.W. 1. Informal meeting. Discussion on "The Possibility of Internal Combustion Locomotives," introduced by Mr. A. E. L. Chorlton. 7 p.m.

THE INSTITUTION OF PUBLIC LIGHTING ENGINEERS AND SUPERINTENDENTS.—Court Room of the Holborn Borough Council offices, 157, High Holborn. First Conference and exhibition of some of the most modern street lighting appliances. 2 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Honorary members' lecture, "Some Suggestions for Road Transport Development," by Mr. D. S. Capper. 7.30 p.m.

OLD CENTRALIANS.—Engineers' Club, Coventry-street, W. 1. Twenty-first annual dinner. 7 for 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse on "The Origin of the Solar System," by Professor J. H. Jeans, F.R.S. 9 p.m.

WEST BROMWICH ENGINEERING SOCIETY.—Technical School, West Bromwich. Lecture, "The Evolution of Hand Tools," by Mr. A. S. Barnes. 7.30 p.m.

SATURDAY, FEBRUARY 16TH.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—Newcastle-upon-Tyne. General meeting. 2 p.m.

MONDAY, FEBRUARY 18TH.

BRADFORD ENGINEERING SOCIETY.—Technical College, Bradford. "The Manufacture of Seamless-drawn Tubes and Sheets of Brass and Copper," by Mr. A. Spittle. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: SCOTTISH CENTRE.—Royal Technical College, Glasgow. Papers, "The Carburetter from the Hydraulic Point of View," by Mr. W. J. Duncan; "Small Diesel Engines," by Mr. James Richardson. 7.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "The Transport, Storage and Distribution of Hydrochloric Acid," by Mr. D. M. Hewitt. 8 p.m.

INSTITUTION OF CIVIL ENGINEERS: NEWCASTLE-ON-TYNE ASSOCIATION.—Neville Hall, Newcastle-on-Tyne. Paper, "Some Applications of Reinforced Concrete in Harbour and Dock Construction," by Mr. W. Simpson. 7.30 p.m.

TUESDAY, FEBRUARY 19TH.

ILLUMINATING ENGINEERING SOCIETY.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Discussion on "Some Aspects of Railway Lighting," to be opened by Messrs. J. F. Caine and E. A. Marx. 8 p.m.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, Tower Hill, E. 1. "Experiments on a Cylindrical Steam Boiler with and without Pre-heated Air," by Mr. D. H. Owen. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: WOLVERHAMPTON CENTRE.—Star and Garter Hotel, Wolverhampton. Paper, "Modern Automobile Foundry Practice," by Mr. H. C. M. Stevens. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Further discussion on "Slips and Wash-outs on the Hill Section of the Assam-Bengal Railway," by Mr. T. R. Nolan; "Under-drainage and its Application to Railway Work," by Mr. R. D. Walker. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND STUDENTS' SECTION.—The University, Leeds. "Single-phase Induction Motors," by Mr. E. Barker. 7 p.m.

MANCHESTER METALLURGICAL SOCIETY.—College of Technology, Manchester. Paper, "The Inner Structure of Metals," by Messrs. F. C. Thompson and E. W. Millington. 7 p.m.

WEDNESDAY, FEBRUARY 20TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Midland Hotel, Derby. Annual dinner of the Derby graduates. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Chamber of Commerce, New-street, Birmingham. Birmingham graduates' meeting. Paper, "Electric Starting and Lighting Equipment for Automobiles and Motor Cycles," by Captain H. C. Burgoine. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Students' meeting. Paper, "The Reconstruction of an Important Bridge on the London, Midland and Scottish Railway," by Mr. C. B. Tryo. 6 p.m.

LIVERPOOL ENGINEERING SOCIETY.—9, The Temple, Dale-street, Liverpool. Paper, "Steel Castings," by Mr. J. Varley. 8 p.m.

ROYAL METEOROLOGICAL SOCIETY.—49, Cromwell-road, South Kensington, London, S.W. 7. General meeting. 7.30 p.m.

THURSDAY, FEBRUARY 21ST.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Watergate House, Adelphi, London, W.C. 2. London graduates' meeting. Paper, "The Possibilities of the Two-stroke Engine for Automobile Purposes," by Mr. L. F. Little. 7.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS.—Denison House, 296, Vauxhall Bridge-road, London, S.W. 1. Paper, "Column Fallacies," by Dr. E. H. Salmon. 7.30 p.m.

UNIVERSITY OF LONDON.—London School of Economics and Political Science, Houghton-street, Aldwych, London, W.C. 2. Lecture, "Britain on the Eve of the Railway Age" (I.). by Dr. J. H. Clapham. 5 p.m.

FRIDAY, FEBRUARY 22ND.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Craven Arms Hotel, Coventry. Coventry graduates' annual dinner. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH MIDLAND STUDENTS' SECTION.—Visit to the Penistone works of Cammell Laird and Co., Limited. Meet at Penistone Station at 2.50 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, London, S.W. 1. Annual general meeting. Resumption of discussion on "Repairs and Upkeep of Pneumatic Tools," by Mr. R. W. Wilson. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "Ciment Fondu: Its Manufacture and Special Uses," by Mr. J. S. Marshall. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse of "The Human Brain," by Professor G. Elliot Smith. 9 p.m.

SATURDAY, FEBRUARY 23RD.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Visit of the London graduates to the works of D. Napier and Son, Limited, Acton, W. 3. 2.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the British Empire Exhibition at Wembley to inspect the railway of Never-Stop Transit, Limited. 2 p.m.

TUESDAY, FEBRUARY 26TH.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, Tower Hill, E. 1. "Electricity as the Motive Power for Ships," by Mr. L. Rothera. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "The Fundamentals of Cost Reduction," by Mr. H. Kerr Thomas. 6.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, London, S.W. 1. Joint meeting with the Society of Chemical Industry. Symposium of papers on "The Treatment of Water for Industrial Purposes." 6 p.m.

WEDNESDAY, FEBRUARY 27TH.

ENGINEERING GOLFING SOCIETY.—The Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. Annual general meeting. 12 o'clock noon.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Birmingham graduates' visit to the works of the Lucas Electrical Company Limited, Well-street, Birmingham. 2.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: NORTH OF ENGLAND CENTRE.—Milton Hall, 244, Deansgate, Manchester. Paper, "Modern Automobile Foundry Practice," by Mr. Percy Pritchard. 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Queen's Hotel, Birmingham. Annual dinner. 7 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the Osram lamp works.

THURSDAY, FEBRUARY 28TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Informal meeting. Paper on the subject of the requirements for motor delivery vans from the point of view of type of unit, accessibility, length of chassis, &c., by Mr. A. E. Cowper. 6.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Special general meeting of corporate members. 5.30 p.m.

UNIVERSITY OF LONDON.—London School of Economics and Political Science, Houghton-street, Aldwych, London, W.C. 2. Lecture, "Britain on the Eve of the Railway Age" (II.), by Dr. J. H. Clapham. 5 p.m.

SATURDAY, MARCH 1ST.

RADIO SOCIETY OF GREAT BRITAIN.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Annual conference of affiliated societies. 2 p.m.

MONDAY, MARCH 3RD.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Graduates' Section. Annual lecture, "Literature and Engineering," by Lieut.-Colonel E. Kitson Clark. 7 p.m.

FRIDAY, MARCH 7TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, London, S.W. 1. Informal meeting. Lecture, "Recovering Gold from the Laurentic," by Commander G. C. C. Damant, R.N. 7 p.m.

WEDNESDAY, APRIL 9TH.

INSTITUTION OF NAVAL ARCHITECTS.—Connaught Rooms, Great Queen-street, London, W.C. Annual dinner. 7.30 p.m.

WEDNESDAY TO FRIDAY, APRIL 9TH TO 11TH.

INSTITUTION OF NAVAL ARCHITECTS.—Royal United Service Institution, Whitehall, London, W.C. 2. Annual general meetings.